

BULLETINS
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VOL. II

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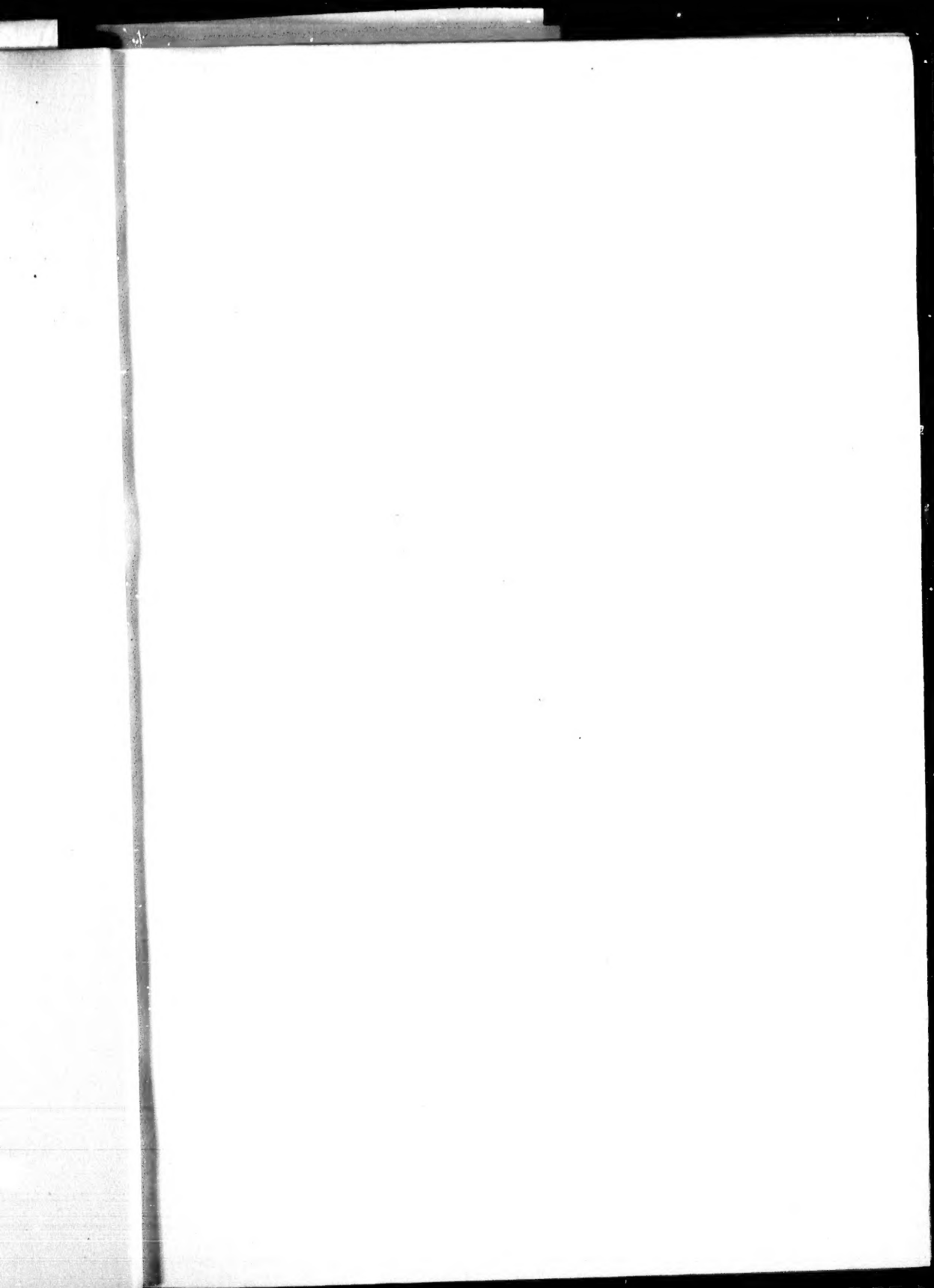
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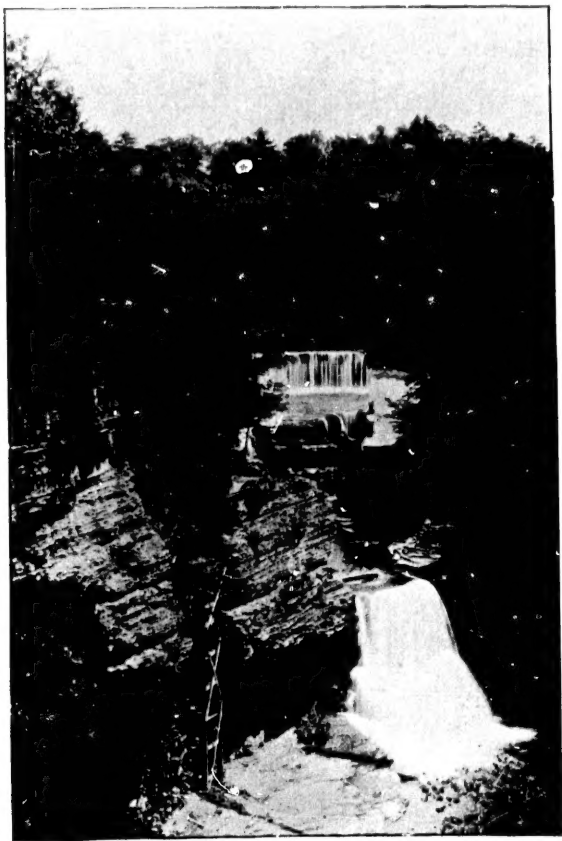


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Triphammer Falls.

A typical Ithaca Group exposure.

See pp. 18-19, stations 9, 10, 11.

Photo by J. O. Martin.

Vol. 2

BULLETINS
OF
AMERICAN PALEONTOLOGY

No. 6

THE RELATION OF THE FAUNA OF THE ITHACA
GROUP TO THE FAUNAS OF THE
PORTAGE AND CHEMUNG

BY

EDWARD M. KINDLE

December 25, 1896

Ithaca, N. Y.
U. S. A.

THE RELATION OF THE FAUNA OF THE ITHACA GROUP TO THE FAUNAS OF THE PORTAGE AND CHEMUNG.

• BY

E. M. Kindle.

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PART I.

INTRODUCTION.

The more recent studies of the Upper Devonian in New York have shown that some of its five divisions are closely related to each other by their fossil remains. Some of the most characteristic fossils of one group often begin to appear in the formation just below it, and to continue, though less abundantly, into the succeeding horizon. It is for this reason often difficult to decide whether a group is more closely related to the beds above or below it. In the case of that at Ithaca, opposite views have been held by the two paleontologists best acquainted with it at the typical locality—Prof. Hall including it in the Chemung and Dr. Williams placing it with the Portage.

The present paper has to offer such data and conclusions on the relations which these faunas sustain to each other as the writer has been able to gather from the detailed study of several sections near Ithaca. All of the material collected during this study has been presented to Cornell University and may be found catalogued in the Paleontological Museum.

BRIEF REVIEW OF THE STUDY OF THE UPPER DEVONIAN IN
NEW YORK.

The basis of the present classification and division of the New York Devonian was developed by the geologists of the New York Survey—Hall, Vanuxem, Conrad and Emmons—during the first ten years of its existence.

The first attempt to determine the age of the New York Devonian by means of its fossil remains was made by Prof. Jas. Hall, who stated in 1838 that he considered "the rocks of the 4th District as belonging to the Old Red sandstone and the Carboniferous group and to be above the Silurian system of Mr. Murchison."*

Prof. Hall first introduced the term Ithaca group in 1839.† As originally defined by him it included the rocks about the south end of Cayuga Lake lying between the Genesee shale, or Black shale as it was first called, and the Chemung.

In the Report for 1840,‡ Lardner Vanuxem gave the name

*2d Ann'l Rep't 4th Geol. Dist., p. 291, 1838.

†3d Ann'l Rep't 4th Geol. Dist., p. 318, 1839.

‡4th Ann'l Rep't 3d Geol. Dist., p. 381, 1840.

Sherburne flagstone to the lower part of Hall's Ithaca group. His classification of the Upper Devonian of New York was as follows:—

Tully limestone.
Black shale.
Sherburne flagstone.
Ithaca group.
Chemung group.
Montrose sandstone or sandstone of Oneonta.

In his Report for the 4th District,* Prof. Hall states that in the Genesee valley the Ithaca group and the Tully limestone are wanting. He recognized there the following formations:—

Portage group.
Gardeau group.
Cashaqua shale.
Encrinal limestone.

In 1842 the geologists of the 3d and 4th Districts had reached opposite views as to the relation of the Ithaca group to the formations above and below it. Mr. Vanuxem states† that he had intended uniting the Sherburne and Ithaca groups into one, while Mr. Hall wished to unite the Ithaca and Chemung. Vanuxem, however, retained the original arrangement, only substituting the name Portage or Nunda group which Hall had used in western New York for Sherburne. No distinct line of division is indicated by Vanuxem between the Ithaca group and the Portage below or the Chemung above. In the Report for 1842,‡ Vanuxem introduced the term "New York System" to include all of the New York formations from the Potsdam sandstone to the Chemung inclusive. The following is his classification of the upper part of the New York System:—

Catskill group.

New York System.—Erie division.

{ Chemung group.
Ithaca group.
Portage group.
Genesee slate.
Tully limestone.
Hamilton group.
Marcellus shales.

Prof. Hall united the Ithaca group with the Chemung in the

* 4th Ann'l Rep't 4th Geol. Dist., p. 390, 1840.

† Final Rep't Surv. of 3d Geol. Dist., p. 171, 1842.

‡ Final Rep't Surv. of 3d Geol. Dist., p. 13, 1842.

Report for 1843 and made the following classification:—

New York System.	{ Erie division.	Chemung group.	{ Portage sandstone.
		Portage or Nunda group.	{ Gardeau flagstone.
		Genesee slate.	{ Cashaqua shale.
		Tully limestone.	{ Moscow shales.
		Hamilton group.....	{ Encrinal limetone.
		Marcellus slate.	{ Ludlowville shales.

Hall states as the reason for uniting the Ithaca and Chemung, the impossibility of distinguishing them by any characteristic fossils. In the valley of the Genesee river Prof. Hall found the three divisions of the Portage distinct and well marked, but toward the south end of Cayuga lake he considered them scarcely distinguishable. He considered the Portage fossils entirely distinct from those above, and states* that he never saw one of the Portage fossils in the higher group. As will be shown later, this opinion was due to the lack of an intimate knowledge of these faunas.

The classification of the Upper Devonian in eastern New York has been attended with much difficulty. The absence or scarcity of fossils in much of the series in that part of the State made its correlation with the well defined faunas to the west difficult and uncertain.

Vanuxem in 1840 recognized † a formation in the 3d District which he considered distinct from the Chemung and more recent. He called this the "Montrose sandstone" from the town of Montrose in Pennsylvania where it is well developed.

Mather included all of the rocks of the Catskill mountains in his "Catskill Mountain Series" which he subdivided as follows ‡:—

1. Conglomerates and grits.
2. { Red and gray grits with red shales mottled with green spots.
3. Montrose sandstone of Prof. Vanuxem.
4. Chemung group of Prof. Vanuxem.
5. Ithaca group of Prof. Vanuxem.
6. Sherburne flags.
7. ———
8. Hamilton group.
9. Marcellus shales.

* Geol. of N. Y., Part 4, p. 229, 1843.

† 4th Ann'l Rep't 3d Geol. Dist., p. 381, 1840.

‡ 5th Ann'l Rep't 1st Geol. Dist., p. 77, 1841.

In his final Report* Vanuxem used the term "Catskill group" for the uppermost member of the New York System which he had previously called Montrose sandstone. The Catskill group continued to be regarded for several years as distinct from and subsequent in time of deposition to the Chemung.

The preliminary work of the classification of the New York strata according to their organic contents into the groups which have since been recognized as the paleontologic units for the United States was completed with the publication of the final reports of the different districts from 1840 to 1843.

In 1847 Edward de Verneuil visited America and correlated the divisions of the New York System with the European formations.† The divisions of the Erie and the five superior divisions of the Helderberg he correlated with the Devonian of England. He proposed to combine the Marcellus shale, Hamilton group and Tully limestone into one division, and the Portage and Chemung groups into a second division of the Devonian.

The discovery in the year 1862 of fish bones of a characteristic Catskill species associated with Chemung fossils in the Catskill rocks created doubt as to the superior position of those deposits. Col. E. Jewett declared his belief that there‡ "is no Old Red sandstone in the State." Prof. Hall was led by the same fact to modify his views of the extent of the Catskill group. He expressed the opinion that the "greater part of the area colored on the geological map of New York as Catskill group is in fact occupied by the Portage and Chemung."§

A comparative study of the Upper Devonian faunas of New York led Prof. H. S. Williams to consider the Chemung and Catskill as contemporaneous formations.||

In his vice-presidential address¶ in 1891 Prof. J. J. Stevenson reviewed in detail the evidence bearing on the relation of the Catskill to the Chemung and their extent. He considered the Catskill and Chemung to have been deposited synchronously in a shallow basin subsiding most rapidly to the east.

Mr. N. H. Darton proposed** as the result of stratigraphical studies in the Catskill region that "Catskill" be broadened

* Geol. of N. Y., Part 3, p. 16, 1842.

† Bull. Geol. Soc. of France, 2d ser., vol. iv.

‡ Am. Jr. Sci., 2d ser., vol. xxxiv, p. 418.

§ Can. Nat. and Jr. of Sci., new ser., vol. vii, p. 377.

|| Bull. U. S. Geol. Surv., No. 41.

¶ Proc. Am. Assoc. Adv. Sci., 1891, p. 241.

** Am. Jr. Sci., 3d Ser., vol. xlv, pp. 203-209.

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from the name of an epoch to that of a period, and that it include the Chemung and Portage epochs. This suggestion to substitute the name of a local formation not well characterized paleontologically for one of wide extent with a very distinctive fauna like the Chemung has not met with favor and has been followed by no other writers.

All recent studies of the Catskill group go to show that it is the stratigraphic equivalent of the Upper Devonian of the central and western parts of the State.

In the detailed and careful study of the relations of the Upper Devonian faunas of New York, Prof. H. S. Williams was the leader; and to him more than to any other student, paleontologists are indebted for our present knowledge of these faunas. In the year 1894 he published the results of the study of a section from Cayuga lake to Bradford county, Pennsylvania. The horizons included in this study are shown in the following section*:—

	Feet.
XII. Barclay coal bed.	
XI. Pottsville conglomerate.	
X. Mauch Chunk Red shale.	1000
IX. Pocono Gray sandstone.	
Catskill Red sandstone.	
Upper Chemung fauna in Penna. (top at Ulster)...	300
Typical Chemung fauna (outcropping in the vicinity of State-line, bottom of Chemung Narrows, N. Y.)	300
Lower Chemung fauna (bottom outcrops at Caroline, Danby and Newfield).....	600
Upper Portage Sandstones and Shales of H. S. Williams.....	600
{ Upper Ithaca.....	200
Middle Portage. { Typical Ithaca.....	100
{ Lower Ithaca.....	150
Lower Portage Sandstones and Shales.....	250
Genesee Shales.....	—
	3500

In this study Dr. Williams attempted to discover the association of the species in faunas and the relation of these to each other. In the Portage rocks at Ithaca two distinct faunas were recognized,—the *Cladochonus* and *Spirifer laevis*,—and the relation of these to those of the Ithaca group was pointed out.†

* Trans. Am. Inst. Min. Engineers, vol. xvi, p. 945.

† Bull. U. S. Geol. Surv., No. 3, p. 11.

In the Ithaca group Williams recognized five faunas—the *Lingula complanata*, *Spirifer fimbriatus*, *Spirifer mesastrialis*, *Rhynchonella eximia* and *Spirifer mesacostalis*.

The *Lingula complanata* fauna is a recurrence with a slight modification of the fauna found in the Marcellus shales and the Genesee slate. The presence of this fauna and the recurrent Hamilton species in the Ithaca fauna he considered to be the result of a shifting of faunas,—new conditions and faunas driving the Hamilton and Marcellus faunas out of the area in question and permitting them to return at intervals, while in some areas they lived on continuously undisturbed by new conditions.

Above the Ithaca fauna Williams found a recurrent Portage fauna containing *Lunulicardium fragile* and *Glyptocardia speciosa*. The occurrence of these characteristic Portage species above the Ithaca fauna led him to refer it to the Portage group instead of the Chemung where Hall placed it.

In western New York the studies of Williams and Clarke have thrown much light on the relations of the Upper Devonian faunas.

In 1883 Prof. Williams published a paper* on a peculiar fauna in Ontario county at the base of the Chemung in what he called the Naples beds. In this fauna he found a majority of forms to be species characteristic of the Lime Creek beds of Iowa, together with a few species peculiar to the Ithaca and Lime Creek faunas. He therefore correlated the fauna of the Naples beds with the Kinderhook in the West and the Ithaca fauna to the east.

In Ontario county, Prof. Clarke, as a result of his studies (published in 1885†) found that the Portage group, as originally defined by Hall, includes an assemblage of unlike faunas, the lower ones being closely related to the Genesee or Hamilton, while the upper are related to the Chemung. The Cashaqua and Gardeau beds of Hall he includes under the name of the Naples shales. Of the 47 species occurring in the Naples shales, Clarke finds that 34 per cent. occur in the Genesee shale and 19 per cent. in the Hamilton proper, while but 2.1 per cent. occur in the Portage. He concludes, therefore, that the Naples beds should be regarded as constituting the uppermost member of the Hamilton, or together with the Genesee, as representing a distinct geological epoch.

* Am. Jr. Sci., vol. xxv, p. 97.

† Bull. U. S. Geol. Surv., No. 16.

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About 600 feet of sandstone above the Naples beds are referred to the Portage. Only ten species have been found in the fauna of these Portage sandstones, seven of which are common to the Chemung.

It should be observed that "Naples beds" as used by Williams and Clarke represent entirely different horizons. Prof. Williams, who introduced the term, applied it to a horizon "about twelve hundred feet above the highest Genesee slate."* Prof. Clarke has applied the same term to a portion of Hall's Portage lying directly above the Genesee; above the Naples beds of Clarke is the Portage sandstone followed by the High-point bed, which latter is equivalent to the Naples horizon of Williams. In order to avoid confusion, the term Naples beds, if used, should at least include the horizon originally designated by Williams.

As regards the absence of the Ithaca fauna from the Upper Devonian of western New York, the results of Prof. Williams' studies of the Genesee section† correspond with those of Clarke and Williams in Ontario county. The fauna of the Portage group of the Genesee section as given by Prof. Williams is very meagre as compared with the Portage as developed at Ithaca, while it contains some of the more characteristic fossils found at Ithaca, as *Glyptocardia speciosa* and *Lunulicardium fragile*. Most of the species which at Ithaca are common to the Portage and Ithaca groups are absent from the Portage of the Genesee section. Immediately following the Portage, Williams finds the typical Chemung fauna. The peculiarities of the Chemung fauna immediately above the Portage fauna indicate that it represents a later stage than the Ithaca fauna. At Hornellsville, about half way between the Genesee and Cayuga sections, *Orthis tioga* of the Chemung, and the Chemung stage of *Spirifer mesacostalis* were found directly above shales carrying the Portage *Glyptocardia* fauna. The occurrence in the western sections, immediately above the Portage, of fossils of a type which in the eastern sections were developed after the Ithaca stage, indicates that in the west the Portage fauna must have continued until after the close of the Ithaca stage in the east.

Previous to his study of the Genesee section, Prof. Williams made a comparative study of ten sections through the Upper Devonian. These extended in an east and west direction from

* Am. Jr. Sci., vol. xxv, p. 97, 1883.

† Bull. U. S. Geol. Surv., No. 41.

the Cuyahoga section near Cleveland, Ohio, to the Chenango section of the Chenango valley. The conclusions which Prof. Williams reached from the study of these sections regarding the character of the Portage, he expresses as follows*: "The Portage rocks and their faunas are comparatively local, belonging to the central part of the area, the fauna failing in the more western sections, and both fauna and lithologic characters are unrecognizable east of the Cayuga section."

Concerning the differences between the faunas of the Portage horizon and the Genesee along the Cayuga and eastern sections he says,† "It is evident from the study of the sections, that the interval occupied in the Genesee section by the typical Portage fauna is represented in the Cayuga section by an entirely different set of species, while still farther east in the Chenango and Unadilla sections the same interval is filled by a preliminary stage of the Catskill."

The views which Williams held of the relation of the fauna of the Ithaca group to its antecedent and subsequent faunas, he states as follows: "The Ithaca group of the State reports contains faunas which I have defined as stages in the successive modification of the Hamilton fauna. This set of faunas differs from the Chemung in the absence of several of its common and abundant species and by presenting unmistakable evidences of earlier stages in modification of species which are near enough alike to be classified under the same specific name."‡

The Ithaca fauna, like the Portage, Williams considers to have a limited geographical extent, being best developed in the east, and blending toward the west with the Portage fauna which in the western sections entirely replaces it. The transition at Hornellsville from the *Glyptocardia* fauna of the Portage directly to the lowest true Chemung fauna characterized by *Orthis tioga* he considers evidence that the Ithaca group has no representative in the region west of there. §

The correlation of the Upper Devonian faunas of central and eastern New York with those of the more western has been attended with considerable difficulty owing to the changes in the several faunas in passing westward. In most of this region the Tully limestone and Genesee shale are absent, their most eastern

* Proc. Am. Assoc. Adv. Sci., vol. xxxiv, p. 233.

† *Ibid.*

‡ *Ibid.*

§ Bull. U. S. Geol. Surv., No. 41, p. 30.

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outcrops being on the west side of the Chenango valley. The absence of these formations leaves no definite line of division between the Hamilton and the faunas above. This has led to much uncertainty as to whether the bluish shales and sandstones underlying the Oneonta sandstone and containing a fauna composed of Hamilton fossils and a few Ithaca group species belong in the Hamilton or above the horizon of the Genesee shale. These faunas of uncertain affinities have been studied in Otsego and Chemung counties by Williams, Prosser and Clarke. While these careful observers agree in the main in their conclusions as to the relations of the faunas of this region there are some differences, and it may be worth while to summarize briefly the results of their published studies.

In his paper on the classification of the Upper Devonian,* Prof. Williams describes the faunas of the Chenango and the Unadilla river sections. The faunas above the Genesee shale in these sections represent, according to him, five stages of the modified Hamilton fauna and one stage of the Chemung. The stages which he recognizes are the *Paracyclas lirata*, *Atrypa reticularis*, *Leiorhynchus globuliformis*, *Tropidoleptus carinatus*, *Spirifer mesastrialis* stages of the Hamilton followed by the *Rhynchonella contracta* stage of the Chemung. The nearly barren sandstones and conglomerates lying above the last of these stages and intervening between the first two are stages of the Catskill. These modified stages of the Hamilton correspond to the Ithaca group of the Cayuga section. Williams finds no representative of the Portage fauna in these sections.

Prof. Prosser has studied the same sections and has published a complete list of the fossils identified by him in the Unadilla section.†

In another paper‡ he discusses the correlation of the Upper Devonian faunas of central and eastern New York. In this Prosser recognizes above the typical Hamilton faunas representing two stages of the western sections, the Portage and the Ithaca group stages. The determination of the Portage stage seems to be based on stratigraphic evidence. The presence of the Portage in the Chenango valley is not shown by the lists of fossils given since none of them are characteristic of the typical western Portage. The lists of fossils indicate that the typical

* Proc. Am. Assoc. Adv. Sci., vol. xxxiv, p. 222.

† 12th Ann'l Rep't State Geol. of N. Y., pp. 1-35.

‡ Am. Jr. Sci., vol. xlvi, pp. 212-230.

Hamilton in the Chenango valley is followed by beds bearing an Ithaca fauna, though these may be the stratigraphic equivalents of the Portage of the western sections.

More recently Prof. J. M. Clarke has studied the fossiliferous beds below the Oneonta sandstone in the Chenango valley. In the western part of Chenango county Prof. Clarke found the *Spirifer mesastrialis* fauna lying unquestionably above the Genesee shales. Where the Genesee and Tully formations in the Chenango valley and the eastern part of the region are absent Clarke makes the presence of *Spirifer mesastrialis* the index of the appearance of the supra-Hamilton fauna. The Portage fauna, according to Clarke, is entirely absent from the Chenango valley. There is, he states,* not a single species common to the typical Portage of the Genesee section and the Ithaca fauna of the Chenango valley.

The Cayuga section, he thinks, represents the mingling of those two faunas, the Portage from the west and the Ithaca fauna from the east.

The immediate successor of the typical Hamilton fauna in this region represents a more perfect and normal development of the Ithaca group fauna, Prof. Clarke thinks,† than is to be found in any of the sections to the west. Overlying the Ithaca group of this region are Oneonta flags and shales. These Oneonta beds Clarke considers to be the equivalent of the typical western Portage. The principal evidence given for this correlation is the occurrence of peculiar concretions found in both formations.

The first diagrammatic presentation of the relations of the Upper Devonian faunas, based on the view that some of them were local faunas imperfectly developed or entirely absent from some of the sections, was a series of sections of the Upper Devonian published by Prof. Williams in 1886.‡

All of the paleontologists who have since studied the New York Devonian have reached similar views as to the local development of the faunas.

Fig. 1, republished from Prof. Clarke's Report§ on the Chenango valley, represents probably as accurately as our present knowledge will permit the relations of the Upper Devonian faunas in the eastern, central and western parts of the State.

* 13th Ann'l Rep't State Geol. of N. Y., p. 555.

† *Ibid.*

‡ Proc. Am. Assoc. Adv. Sci., vol. xxxiv.

§ 13th Ann'l Rep't State Geol. of N. Y., p. 556.

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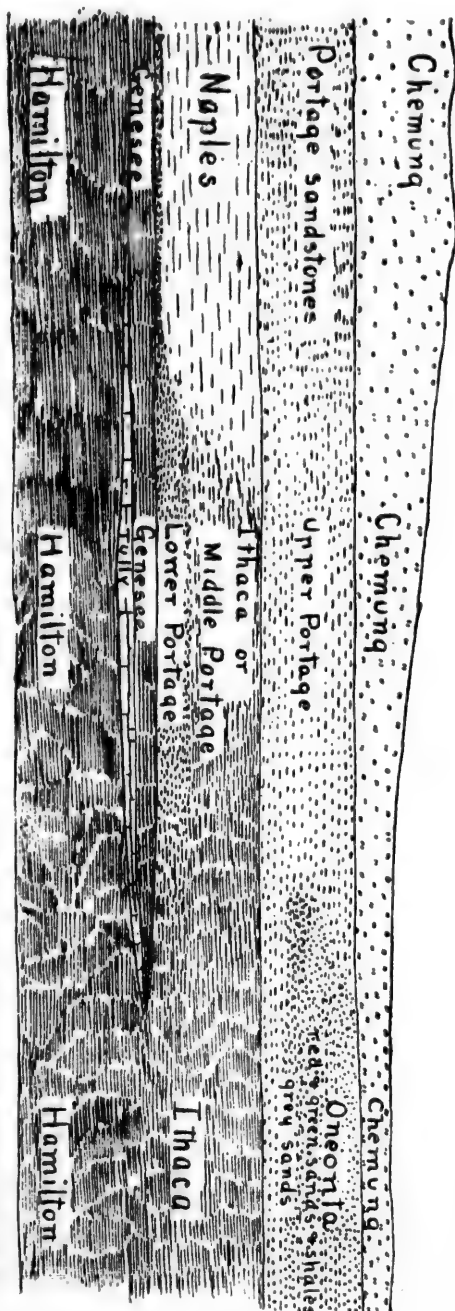
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FIG. 1.—From an electrolyte copy of the original plate used in printing p. 556 of the 13th Ann'l Rept State Geol. of N. Y.



Naples section
(Clarke)

Ithaca section
(Williams)

Chemung Valley
Section

PART II.

THE ITHACA SECTIONS.

Stratigraphy.—The rocks of the Portage and the Ithaca groups outcrop along the sides of Cayuga lake valley about Ithaca, New York. The Portage rocks rest upon the black Genesee shale, and are terminated above by the Ithaca shale. Tough sandstone flags, often wave-marked, together with beds of more arenaceous character, constitute the Portage rocks, which are here about 250 feet in thickness. The base of the Portage is sharply defined by a fine-grained, hard, blue sandstone about 3 feet in thickness. From Esty's glen to the point where the base of the Portage passes below the surface of the lake, the dip is more than 100 feet to the mile. Near Ithaca the dip becomes less, and to the south it is very slight for several miles.

The soft argillaceous beds which lie above the Portage have been called the Ithaca shale by Prof. Williams. These shales are often stained a reddish brown by iron. Lenticular layers of sandstone sometimes occur in these shales. Above the base of the Ithaca shale 25 or 30 feet, it loses its arenaceous character and is replaced by the sandstone flags and intercalated shales which contain the typical Ithaca fauna. These beds are fossiliferous for a thickness of nearly 400 feet. The rocks containing the Ithaca fauna are followed by nearly 600 feet of barren sandstone flags which extend to the tops of the hills about Ithaca. The fossiliferous beds of the Chemung do not appear in the immediate vicinity of Ithaca, but several miles to the south they form the tops of the hills along the southern extension of Cayuga valley above the barren strata.

The numerous deep gorges of the streams entering the Cayuga valley afford excellent exposures of the rocks about Ithaca, from the base of the Portage to the top of the Ithaca group. Ten sections through these rocks have been carefully studied and the results are given in the following pages.*

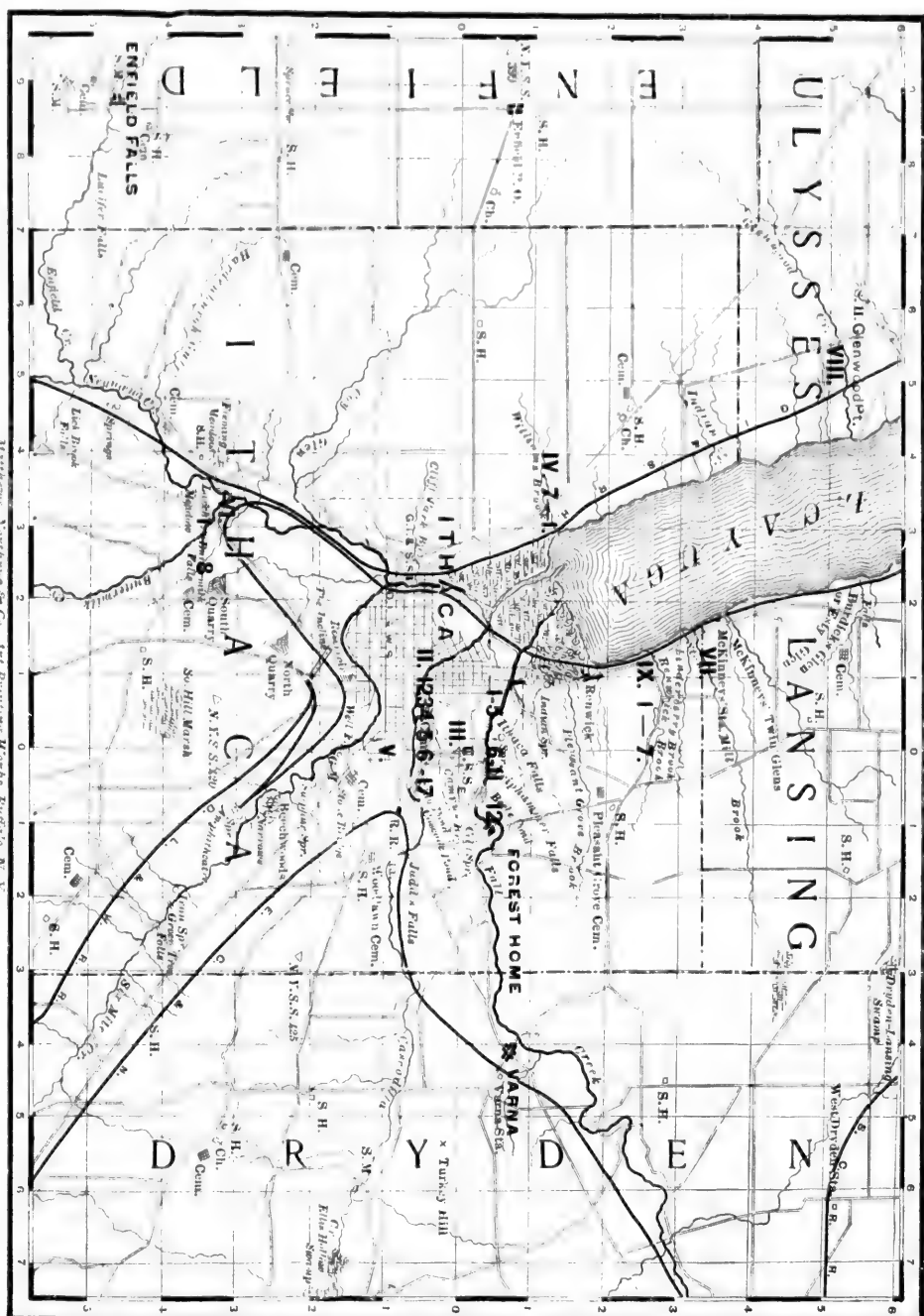
*NOTE.—The sections are numbered in the order in which they were studied. All of the specimens on which the lists of species are based are in the Paleontological Museum. Two numbers are attached to each specimen, the first indicating the section, and the second the stratigraphic position or station in the section from which it came, *e. g.*, 1-2 refers to the second station in the Fall Creek section.

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Map.—Ithaca and vicinity, showing location of sections and stations. (From Prof. Gage's plate).



Section I, Fall Creek.

This section begins in the upper Portage sandstone at the foot of Ithaca falls and ends at the outcrops in the bed of the stream above Forest Home. This section includes about 410 feet of strata.

Station 1.—The fauna of this station occurs in the Portage flagstone and shale exposed at the foot of Ithaca falls. This is the best locality known for collecting *Spirifer laevis*, which is the predominant species, and its associated fauna.

The following is a list of species obtained from about three feet of strata: *Spirifer laevis* a, *Spathella typica* c, *Goniatites sinuosus*? r, *Crania* sp. r, *Cyrtina hamiltonensis* r, *Lunulicardium fragile* a, *Palæoneilo filosa* a, *Orthoceras pector* r, *Aviculopecten lautus* var. *ithacensis* r, *Goniatites discoides* c, *Modiomorpha subalata*, *Grammysia subarcuata* r, *Taxocrinus ithacensis* stems, *Chonetes lepida* a, *Pleurotomaria capillaria* r, *Chonetes scitula* r, *Gomphoceras tumidum* r, *Glyptocardia speciosa* r, *Coleolus tenuicinctus*, *Nucula diffidens* r, *Mytilarca chemungensis*? r, *Leiorhynchus mesacostalis*, *Lingula ligea*? r, *Plumulina plumaria* c, *Aviculopecten rugastriatus*?, *Leda diversa*.

Station 2.—135 feet above *Station 1*.

The rocks containing the fauna of the Ithaca shale are exposed in the vertical cliffs of the falls, so that no representative of it were obtained from this section.

At the summit of Ithaca falls the sandstone and silicious shale contain the following species, indicating the initiation of the Ithaca fauna: *Productella speciosa* c, *Spirifer mesacostalis*, *Chonetes setigera* c, *Ambocelia umbonata* c, *Pleurotomaria capillaria*, *Microdon tenuistriatus*, *Stictopora meeki* c, *Palæoneilo constricta*, *Aclinopteria boydi*, *Orthoceras bebryx* var. *cayuga*, *Modiomorpha subalata* var. *chemungensis* c, *Nucula corbuliformis*.

Station 3.—From the foot of the cascade below the electric light plant, the following species were collected: *Ambocelia umbonata* a, *Chonetes scitula*, *Rhynchonella eximia* a, *Palæoneilo filosa*, *Leiorhynchus mesacostalis*, *Gomphoceras tumidum* r, *Modiomorpha subalata* var. *chemungensis*, *Aclinopteria boydi*? r, *Spirifer mesastrialis* a, *Microdon bellistriatus* r, *Stictopora meeki*, *Pleurotomaria capillaria* r, *Grammysia subarcuata*?, *Cyrtina hamiltonensis* c, *Pro-*

* The letter placed after a species refers to its abundance,—a, indicating abundant, c, common and r, rare.

Productella speciosa, *Conularia congregata* a, *Monticulopora* sp. r, *Coelolus tenuicinctus* r.

Station 4.—From the top of the cascade at the electric light plant, the following species were obtained: *Spirifer mesastrialis* c, *Leiorhynchus mesacostalis* r, *Microdon bellistriatus*, *Pleurotomaria capillaria* r, *Aclinopteria perstialis*?, *Plumaria plumulina* r, *Stictopora meeki* c, *Orthoceras bebyx* var. *cayuga*.

Station 5 (a).—The following species were obtained a short distance above *Station 4*: *Cyrtina hamiltonensis*?, *Ambocelia umbonata*, *Spirifer mesacostalis* r, *Leiorhynchus mesacostalis* c, *Rhynchonella eximia* c, *Rhynchonella stephani* c, *Grammysia subarcuata*, *Stictopora meeki*, *Aclinopteria perstialis*, *Palæoneilo filosa*, *Modiomorpha subalata* var. *chemungensis* c, *Plumaria plumulina*.

Station 5 (b).—About four feet higher than 5a, just below the foot bridge, in a calcareous layer, the following species occur: *Productella speciosa* a, *Orthis impressa* c, *Atrypa reticularis* c, *Rhynchonella pugnus* c, *Stictopora meeki*.

It will be observed that this is the first occurrence in this section of the last three brachiopoda noted above.

Station 6.—The following species occur in the first exposures above the foot bridge: *Orthis impressa*, *Palæoneilo filosa*, *Strophodonta mucronata* c, *Productella speciosa*, *Aclinopteria boydi*? r, *Grammysia subarcuata*, *Tentaculites bellulus*, *Chonetes lepida*, *Chonetes scitula*, *Spirifer mesacostalis* a, *Goniatites sinuosus*?, *Atrypa reticularis*.

Station 7.—In the bottom of the gorge, a short distance above *Station 6*, the following species occur: *Strophodonta mucronata* a, *Productella speciosa*, *Crania* sp., *Pterinea chemungensis*?, *Spirifer mesacostalis* a, *Atrypa reticularis*, *Palæoneilo filosa* r, *Platyceras dumosum*? r, *Orthis impressa* c, *Aviculopecten cancellatus*? r, *Cyrtina hamiltonensis* r, *Goniatites complanatus* r, *Pterinopecten erectus* r, *Modiomorpha subalata* var. *chemungensis* r, *Panenka* sp?.

Station 8.—Just below Triphammer falls, the following species were noted: *Strophodonta mucronata* a, *Goniatites complanatus*?, *Chonetes scitula* r, *Productella speciosa* c, *Orthis impressa* r, *Platyceras erectum* r, *Spirifer mesastrialis* r.

Station 9.—From the lower shelf of Triphammer falls, the following species were obtained: *Chonetes scitula*, *Strophodonta perplana* var. *nervosa*, *Crania* sp., *Productella speciosa* a, *Stropho-*

donta mucronata a, *Spirifer mesacostalis* a, *Atrypa reticularis* a, *Goniatites complanatus*? r, *Edmondia subovata* r, *Nucula corbuliformis* r, *Ambocœlia umbonata* r, *Microdon bellistriatus* c, *Grammysia subarcuata* r, *Palæoneilo filosa* c, *Orthoceras bebryx* var. *cayuga*, *Aviculopecten*, *Cyrtina hamiltonensis*, *Aëlinopteria boydi* r.

Stations 10 & 11.—The lists of fossils from two slightly different horizons at the top of Triphammer falls having the same fauna have been combined in the following list: *Schizodus chemungensis*, *Edmondia subovata*, *Nucula diffidens*, *Lunulicardium fragile* r, *Cyrtina hamiltonensis* a, *Aëlinopteria boydi* c, *Productella speciosa* c, *Atrypa reticularis* a, *Modiomorpha subalata* var. *chemungensis* c, *Spirifer mesacostalis* c, *Chonetes setigera* c, *Microdon bellistriatus* r, *Aviculopecten* sp., *Pterinopecten erectus* r, *Crania* sp. r, *Palæoneilo plana* c, *Orthoceras* sp. r, *Platyceras* sp. r, *Mytilarca chemungensis* r, *Palæoneilo filosa* c, *Spathella typica* r, *Goniophora minor* r, *Strophodonta mucronata* a, *Macrodon* sp. r, *Orthis impressa* c, *Pleurotomaria capillaria* r, *Chonetes scitula* c, *Orthoceras bebryx* var. *cayuga*? r, *Aulopora* sp. r, *Chonetes lepidoda* r, *Orthoceras demus*? r, *Productella hallana* r.

Station 12.—The following species were obtained at the old quarry above Triphammer falls: *Strophodonta mucronata* a, *Palæoneilo constricta*, *Cyrtina hamiltonensis*, *Spathella typica*, *Schizodus chemungensis*, *Chonetes scitula*, *Spirifer mesacostalis*, *Productella speciosa*; *Aëlinopteria boydi*, *Pterinea* (*Vertumnia*) *reproba*.

Station 13.—Below lower bridge, Forest Home.

The shales here contain an abundance of fossils, of which the following species were identified: *Strophodonta mucronata*, *Orthonota parvula*, *Modiomorpha subalata* var. *chemungensis*, *Grammysia subarcuata*, *Palæoneilo maxima*, *P. plana*, *P. constricta*, *Crania* sp?, *Chonetes scitula*, *Orthoceras* sp., *Rhynchonella pugnus*, *Schizodus chemungensis*, *Leda diversa*, *Spirifer mesacostalis*, *Spathella typica*, *Atrypa reticularis*, *Aëlinopteria boydi*, *Bellerophon ithacensis*, *Aviculopecten cancellatus*, *Pleurotomaria* sp., *Pterinopecten* (*Vertumnia*) *reproba*, *Arthroacantha ithacensis*.

Prof. H. S. Williams informed the writer that he discovered *Spirifer lævis* and its associated fauna near this station but they have not been re-discovered.

Section II, Cascadilla Creek.

The Cascadilla creek section embraces the rocks exposed along the gorge from the old mill to Eddy's dam,—about 320 feet of strata.

Station 1.—This station is in the dark Ithaca shale at the base of the lowest cascade in the gorge. The species common here are typical of the Ithaca shale. They are *Lunulicardium fragile*, *Lingula complanata*, *Leiorhynchus mesacostalis* (sm. var.), *Rhynchonella eximia*.

Station 2.—About 30 feet above *Station 1*, the following species occur: *Glyptocardia speciosa*, *Productella truncata*, *Palæoneilo filosa*, *Leiorhynchus mesacostalis*, *Microdon bellistriatus*, *Orthoceras* sp., *Palæoneilo plana*, *Pleurotomaria capillaria*, *Microdon gregarius*.

Stations 3 & 4.—About 55 feet above *Station 1*, the following species were found: *Palæoneilo filosa*, *Nucula diffidens*, *N. corbuliformis*, *Microdon gregarius*, *Chonetes scitula*, *Palæoneilo maxima*, *Rhynchonella eximia*, *Modiomorpha subalata* var. *chemungensis*, *Spirifer mesacostalis*, *Leiorhynchus mesacostalis*, *Pleurotomaria capillaria*?, *Productella speciosa*, *Orthoceras* sp., *Aëlinopteria boydi*.

Station 5.—95 feet above *Station 1*, the following species were obtained: *Spirifer mesacostalis*, *Rhynchonella eximia*, *Nucula diffidens*, *Palæoneilo constricta*, *P. filosa*, *P. plana*, *P. maxima*, *Aëlinopteria perstrialis*, *Modiomorpha subalata* var. *chemungensis*, *Microdon gregarius*, *Chonetes setigera*, *C. scitula*.

Station 6.—122 feet above *Station 1*, the following species occur: *Microdon bellistriatus*, *Aëlinopteria boydi*, *Rhynchonella stephani*, *Spirifer mesastrialis*, *Grammysia subarcuata*, *Nucula corbuliformis*, *Pleurotomaria capillaria*, *Modiomorpha subalata* var. *chemungensis*, *Ambocelia umbonata*, *Spirifer mesacostalis*, *Leiorhynchus mesacostalis*, *Orthoceras* sp., *Chonetes scitula*, *Palæoneilo maxima*, *P. constricta*, *P. filosa*, *Cyrtina hamiltonensis*, *Cryptonella eudora*.

Station 7.—The following species were obtained 150 feet above *Station 1*: *Spirifer mesacostalis*, *Pterinea reproba*, *Pleurotomaria capillaria*, *Leptodesma sociale*, *Chonetes scitula*, *Aëlinopteria perstrialis*?, *Stictopora meeki*, *Goniatites* sp., *Grammysia elliptica*, *Chonetes setigera*, *Aëlinopteria* sp?, *Cyrtina hamiltonensis*, *Bellerophon* sp., *Modiomorpha subalata* var. *chemungensis*, *Aëlinopteria boydi*, *Palæoneilo plana*, *Rhynchonella eximia*, *Plumulina plumaria*,

Gomphoceras tumidum, *Cryptonella eudora*.

Station 8.—The following fauna was noted 180 feet above Station 1: *Pleurotomaria capillaria*?, *Palaeoneilo plana*, *Productella speciosa*, *Spirifer mesacostalis*, *Cryptonella eudora*, *Aëlinopteria boydi*, *Stictopora meeki*, *Rhynchonella eximia*, *Modiomorpha subalata* var. *chemungensis*, *Cyrtina hamiltonensis*.

Station 9.—I have obtained the following species 195 feet above Station 1: *Cyrtina hamiltonensis*, *Gomphoceras tumidum*, *Aëlinopteria perstrialis*, *Pleurotomaria capillaria*, *Spathella typica*, *Orthoceras bebyx* var. *cayuga*, *Nucula corbuliformis*, *Schizodus chemungensis*, *Palaeoneilo plana*, *P. constricta*, *Elymella nuculoides*?, *Stictopora meeki*, *Spirifer mesastrialis*, *Chonetes scitula*.

Station 10.—At the foot of the falls, just below Heustis Street bridge, 225 feet above Station 1, the following species occur: *Atrypa reticularis*, *Productella speciosa*, *Rhynchonella pugnus*, *Orthis impressa*, *Spirifer mesacostalis*, *Cyrtina hamiltonensis*, *Strophodonta mucronata*.

Stations 11 & 12.—From the arenaceous sandstone and shale under the Heustis Street bridge, the following species were obtained: *Aulopora* sp., *Palaeoneilo filosa*, *Mytilarca chemungensis*, *Spirifer mucronatus*, *Aëlinopteria boydi*, *Orthis impressa*, *Productella speciosa*, *Cyrtina hamiltonensis*, *Strophodonta perplana* var. *nervosa*, *S. mucronata*, *Orthoceras pectorator*, *Rhynchonella pugnus*, *Schizodus chemungensis*, *Microdon bellistriatus*, *Palaeoneilo constricta*, *Modiomorpha subalata* var. *chemungensis*, *Edmondia subovata*?, *Goniophora minor*?, *Microdon chemungensis*.

Station 13.—The following species were obtained below the electric railroad bridge, 285 feet above Station 1: *Atrypa reticularis*, *Loxonema* sp., *Productella speciosa*, *Microdon* sp., *Strophodonta mucronata*, *Chonetes scitula*, *C. lepida*, *Goniophora minor*?, *Modiomorpha subalata* var. *chemungensis*, *Cyrtina hamiltonensis*, *Schizodus chemungensis*, *Goniatites* sp., *Palaeoneilo filosa*, *Strophodonta perplana* var. *nervosa*, *Aviculopecten* sp.

Station 14.—The following fauna was found 300 feet above Station 1: *Edmondia subovata*, *Chonetes lepida*, *Ptychodesma nanum*?, *Pleurotomaria capillaria*, *Palaeoneilo filosa*, *P. constricta*, *Mytilarca chemungensis*, *Microdon bellistriatus*, *Aëlinopteria perstrialis*?, *Bellerophon leda*, *Modiomorpha subalata* var. *chemungensis*, *Macrodon* sp., *Strophodonta mucronata*, *S. perplana* var. *nervosa*, *Aëlinopteria boydi*, *Atrypa reticularis*, *Pterinea* sp?, *Lunulicardium fragile*,

Grammysia subarcuata, *Nucula corbuliformis*?, *Spirifer mesacostalis*, *Productella speciosa*, *Pterinopecten reproba*?, *Ambocelia umbonata*, *Macrodon chemungensis*.

Station 15.—305 feet above *Station 1*, the following fauna occurs: *Palæoneilo plana*, *P. filosa*, *P. constricta*, *Macrodon chemungensis*, *Crania* sp., *Atrypa reticularis*, *Aclinopteria boydi*, *Spathella typica*, *Schizodus chemungensis*, *Aulopora* sp., *Microdon bellistriatus*, *Pleurotomaria capillaria*?, *Cyrtina hamiltonensis*, *Strophodonta mucronata*, *Spirifer mesacostalis*, *Chonetes scitula*, *Nucula corbuliformis*?

Station 16.—The fauna of this station occurs under the foot bridge below the dam, 320 feet above *Station 1*: *Palæoneilo constricta*, *P. filosa*, *P. plana*, *Microdon bellistriatus*, *Cyrtina hamiltonensis*, *Crania* sp., *Productella speciosa*, *Pleurotomaria capillaria*, *Spirifer mucronatus*, *Modiomorpha subalata* var. *chemungensis*, *Bellerophon leda*?, *Chonetes scitula*, *Atrypa reticularis*, *Spathella typica*, *Strophodonta mucronata*, *Schizodus chemungensis*.

Stations 17 & 18.—The following species were obtained from the beds exposed at the end of the foot bridge, about 10 feet above the last station: *Schizodus chemungensis*, *Atrypa reticularis*, *Chonetes scitula*, *Crania hamiltoniæ*?, *Strophodonta mucronata*, *Grammysia* sp., *Aclinopteria boydi*, *Microdon bellistriatus*, *Chonetes lepidus*, *Modiomorpha subalata*, *Palæoneilo filosa*, *Productella speciosa*, *Spathella typica*?, *Tentaculites spiculus*, *Cyrtina hamiltonensis*, *Modiomorpha subalata* var. *chemungensis*, *Crania* sp., *Goniophora minor*, *Palæoneilo constricta*, *Aviculopecten* sp., *Nucula diffidens*, *Stictopora meeki*, *Spirifer mesacostalis*, *Grammysia subarcuata*, *Orthoceras bebryx* var. *cayuga*.

Section III, University, McGraw and Cornell Quarries

This section includes only about 60 feet of Ithaca group strata.

Station 1.—The quarry below the McGraw-Fiske mansion at the edge of Fall Creek gorge, which is 175 feet above the *Spirifer lævis* bed at the foot of the falls, furnished the following fauna: *Cyrtina hamiltonensis* 1, *Leiorhynchus mesacostalis* c, *Spirifer mesacostalis* c, *Grammysia subarcuata*? 1, *Microdon bellistriatus* c, *Goniophora* sp., *Modiomorpha subalata* var. *chemungensis* c, *Rhynchonella eximia*, *Palæoneilo filosa*, *Chonetes scitula* a, *C. setigera* c, *Orthoceras bebryx* var. *cayuga* 1, *Pleurotomaria capillaria*

r, *Lingula complanata* r, *Palæoneilo plana*.

Station 2.—The quarry in the cemetery lies about 25 feet above the last. *Plumulina plumaria* occurs here rather abundantly. Some of the species associated with it are *Pleurotomaria capillaria*, *Rhynchonella eximia*, *Spirifer mesacostalis*, *S. mesastrialis*, *Aetinopteria* sp.

Station 3.—University quarry is about 235 feet above the *Spirifer laevis* zone in Fall creek. The *Spirifer mesastrialis* fauna reaches its best development here. The species identified from this quarry are as follows: *Spirifer mesastrialis* a, *S. mesacostalis* c, *Rhynchonella eximia* c, *Cryptonella eudora* a, *Bellerophon* sp?, *Spathella typica*?, *Platystoma lineatum* var. *callosum* r, *Pleurotomaria capillaria* r, *Cyrtina hamiltonensis* c, *Pterinopecten erectus* r, *Stictopora meeki* c, *Gomphoceras tumidum* r, *Aetinopteria boydi*, *Orthoceras bebyx* var. *cayuga*, *Leptodesma sociale*?

Section IV, Williams Creek.

This section affords a good continuous exposure of the rocks from the upper *Spirifer laevis* zone of the Portage well up into the Ithaca group.

Station 1.—At the southwest corner of the lake, about 6 feet above its level, the upper Portage *Spirifer laevis* fauna occurs. The following species were found: *Spirifer laevis*, *Aulopora* sp., *Palæoneilo filosa*, *Orthoceras* sp., *Crania* sp., *Cyrtina hamiltonensis*.

Station 2.—At the old quarry near the railroad, about $\frac{1}{2}$ mile south of Williams creek, the following species were obtained about 15 feet above the level of the lake: *Goniatites discoideus*, *Palæoneilo filosa*, *Orthoceras* sp., *Chonetes lepida*?, *Leptodesma* sp., *Palæoneilo constricta*, *Aulopora* sp.

Stations 3 & 4.—These two stations occur in the Ithaca shale about 60 feet above the lake. The following species were found: *Lunulicardium fragile* c, *Productella speciosa* a, *Lingula complanata* a, *Leptodesma sociale*, *Orthoceras pector*.

Station 5.—This station is 265 feet above the lake in a bed of impure limestone about 5 feet in thickness. Nearly all of the following list of species are from this limestone, but a few are from the shale immediately beneath: *Atrypa reticularis* a, *A. spinosa* c, *Spirifer mesacostalis*, *S. mesastrialis* c, *Cyrtina hamiltonensis* c, *Cryptonella eudora* c, *Leiorhynchus mesacostalis*, *Stictopora*

meeki a, *Palæoneilo filosa* r, *P. constricta* r, *Mytilarca chemungensis* c, *Rhynchonella pugnus* a, *Goniatites sinuosus* r, *Productella speciosa* a, *Spirifer mesacostalis* a, *Goniatites complanatus?* r, *Actinopteria boydi?* r, *Orthoceras* sp. c, *Strophodonta mucronata*, *S. perplana* var. *nervosa*, *S. demissa?* r, *Bellerophon* sp. r, *Goniophora minor* r, *Modiomorpha subalata* var. *chemungensis* c, *Nucula diffidens* c, *N. corbuliformis*, *Glossites depressus* r, *Rhynchonella eximia* c, *R. stephani*, *Schizodus chemungensis* r, *Microdon gregarius*, *Pterinopecten* sp., *Aviculopecten striatus* r, *Pleurotomaria capillaria*, *Platyceras* sp., *Actinopteria boydi*, *Orthis impressa* a, *Grammysia subarcuata* r, *Zaphrentis simplex?* r.

Station 6.—This horizon, which is just above the wagon road and 330 feet above the lake, afforded the following species: *Orthis impressa*, *Atrypa reticularis*, *A. aspera*, *Productella speciosa*, *Spathella typica*, *Strophodonta perplana* var. *nervosa*, *S. mucronata*, *Chonetes setigera*, *Rhynchonella pugnus*, *Goniatites complanatus*, *Spirifer mesacostalis*, *Mytilarca chemungensis*, *Orthoceras* sp.

Station 7.—About 10 feet above the last station, the following species were collected: *Grammysia* sp?, *Porcellia nais*, *Atrypa reticularis*, *Spirifer mucronatus*, *Orthis* sp., *Productella speciosa*, *Chonetes lepida*, *Palæoneilo filosa*, *Platyceras bucculentum*, *Strophodonta mucronata*, *Actinopteria boydi*.

Section V, Quarries.

This section has for its lowest station a rock exposure in the bank of Six Mile creek at the Cayuga Street bridge. All the other stations are in the quarries on South Hill and on the north side of Six Mile creek. The section includes a thickness of 230 feet beginning in the Ithaca shale.

Station 1.—Six Mile creek at Cayuga Street crossing.

Just above the Cayuga Street bridge, about ten feet of dark shale are exposed. The following three species of the Ithaca shale are found here rather abundantly: *Lunulicardium fragile*, *Lingula complanata*, *Glyptocardia speciosa*.

Station 2.—Quarry at Inclined plane, 115 feet above *Station 1*. The following species were obtained here: *Chonetes scitula*, *Spirifer mesacostalis*, *Spathella typica?*, *Leiorhynchus mesacostalis*, *Palæoneilo constricta*.

Station 3.—Quarry at the south end of Hazen Street.

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Productella
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nata, *S. per-*
Goniophora
Nucula diffi-
onella eximia
a gregarius,
a capillaria,
Grammysia

e wagon road
species: *Or-*
tella speciosa,
S. mucronata,
complanatus,
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The lower layers of the sandstone contain an abundance of fossils. The most abundant species are *Rhynchonella eximia*, *Leiorhynchus mesacostalis*, *Modiomorpha subalata* var. *chemungensis*.

The following is a list of the less abundant, associated species: *Orthoceras bebryx* var. *cayuga*, *O. leander*, *Stictopora meeki*, *Aclinopteria perstrialis*, *Callonema* sp., *Leptodesma* sp., *Discina grandis*, *Goniophora hamiltonensis*, *Nucula diffidens*, *Plumulina plumaria*, *Conularia congregata*, *Schizodus chemungensis*, *Microdon bellistriatus*, *Productella speciosa*, *Ambocælia umbonata*?, *Spirifer mesastrialis*, *Leptodesma matheri*?, *Grammysia subarcuata*, *G. bisulcata*, *Chonetes scitula*, *Gomphoceras tumidum*, *Leiopteria* sp?, *Tentaculites spiculus*, *Modiomorpha mytiloides*, *Strophodonta perplana*.

Station 4.—Quarry at the south end of Cayuga street.

The sandstone here is inclined to be shelly and thin bedded. Fossils are not very abundant. The following species were collected: *Rhynchonella eximia* c, *Chonetes setigera*, *C. scitula*, *Lingula complanata*, *Microdon bellistriatus*, *Grammysia subarcuata*?, *Modiomorpha subalata* var. *chemungensis* c, *Orthoceras bebryx* var. *cayuga*, *Pleurotomaria capillaria*, *Plumulina plumaria*.

The occurrence of *Lingula complanata*, of which a single specimen was found at this station in the midst of the Ithaca fauna, is worthy of special note. This is the most abundant and characteristic species of the Ithaca shale, but is seldom found in the typical Ithaca fauna.

Station 5.—Quarry southwest of Quarry Street bridge, 140 feet above *Station 1*.

The following species occur here, the first four being very abundant in some layers: *Rhynchonella eximia*, *Spirifer mesacostalis*, *S. mesastrialis*, *Stictopora meeki*, *Glossites depressus*?, *Leiorhynchus mesacostalis*, *Platyceras* sp?, *Orthoceras bebryx* var. *cayuga*, *Cryptonella eudora* r, *Microdon bellistriatus*, *Modiomorpha subalata* var. *chemungensis*, *Pterinopecten erectus*, *Discina grandis*.

Station 6.—Inclined plane above the railroad, 170 feet above *Station 1*.

The species constituting the bulk of the fauna at this locality are *Spirifer mesastrialis*, *S. mesacostalis*, *Stictopora meeki*.

Species less common are *Palæoneilo filosa*, *Cyrtina hamiltonensis*.

Station 7.—Quarry at the south end of Hazen street, 230 feet above *Station 1*.

The following is the list of species obtained at this quarry:

Schizodus chemungensis, *Chonetes lepida*, *C. scitula*, *Leda diversa*, *Orthis impressa*, *Spirifer mesastrialis* a, *Aclinopteria boydi*?, *Rhynchonella pugnus* c, *Crania* sp., *Strophodonta perplana* var. *nervosa*, *Goniophora minor*, *Strophodonta mucronata*, *Aclinopteria* sp., *Microdon bellistriatus*, *Orthoceras bebryx* var. *cayuga*, *Aulopora* sp., *Ambocelia umbonata*, *Pterinea reproba*, *Palaeoneilo plana*, *Productella speciosa*, *Cyrtina hamiltonensis*, *Atrypa reticularis*, *Porcellia nais*?, *Mesothyra* sp., *Arthroacantha ithacensis*.

Spirifer mesastrialis and *Productella speciosa* are the predominant species at this station. *Strophodonta perplana* var. *nervosa*, which is not a common species at most localities, is rather common in the upper part of the quarry. *Rhynchonella pugnus* is also quite common in the lower part of the quarry.

Section VI, Buttermilk Creek.

This section includes about 250 feet of strata beginning in the Ithaca shale at the base of Buttermilk falls.

Station 1.—Base of Buttermilk falls.

A very interesting fauna occurs in the dark shale at the foot of the falls. The following species have been recognized: *Lingula punctata* a, *L. spatulata*?, *Leiorhynchus mesacostalis* a, *Orthis vanuxemi* a, *Palaeoneilo constricta*, *Coleolus* sp., *Loxonema delphicola* c, *Pleurotomaria capillaria*, *Grammysia subarcuata* c, *Leptodesma sociale*, *Ambocelia umbonata*, *Aclinopteria* sp., *Stictopora meeki*, *Productella speciosa* (sm. var.), *Rhynchonella eximia*?, *Nucula diffidens* c, *Orthoceras* sp., *Macrocheilus* (*Holopea*) *macrostomus*?, *Phthonia cylindrica*.

The Ithaca shale fauna at this station contains three species which have not before been recognized in the Ithaca group. Two of these are referred with doubt, owing to the slightly flattened condition of the specimens to *M. rocheilus* (*Holopea*) *macrostomus* and *Phthonia cylindrica*, both of which are Hamilton species. The specimens referred to *Orthis vanuxemi* are identical with the Hamilton specimens of this species; they occur abundantly through a few inches of strata.

Station 2.—60 feet above *Station 1*.

The following is a list of the species collected at this point: *Modiomorpha subalata* var. *chemungensis*, *Nucula diffidens*, *Palaeoneilo filosa* a, *P. constricta*, *Stictopora meeki*, *Lunulicardium fragile*, *Macrocheilus* sp., *Pleurotomaria capillaria*, *Schizodus* sp., *Modio-*

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Station 3.—97 feet above *Station 1*.

The following species were obtained at this station: *Microdon gregarius*, *Modiomorpha subalata* var. *chemungensis*, *Rynchonella eximia*, *Lingula spatulata*, *Productella speciosa*, *Nucula diffidens?*, *Palæoneilo constricta* a, *Leiorhynchus mesacostalis* a, *Chonetes scitula*, *Palæoneilo plana?*

Station 4.—162 feet above *Station 1*.

The following species were obtained from the dark arenaceous sandstone above the falls: *Spirifer mesacostalis* c, *Cyrtina hamiltonensis*, *Stictopora meeki*, *Modiomorpha subalata?*, *M. subalata* var. *chemungensis*, *Palæoneilo constricta*, *Nucula corbuliformis?*, *Leda diversa*, *Actinopteria perstrialis* a.

This station is the first of this section in which *Spirifer mesacostalis* occurs in abundance and marks the beginning of the typical Ithaca fauna.

Station 5.—At the foot of the dam, 182 feet above *Station 1*.

The sandstone flags here contain an abundant fauna similar to that in the University quarry. The following species were identified: *Spirifer mesastrialis* a, *S. mesacostalis* a, *Cryptonella eudora*, *Cyrtina hamiltonensis*, *Stictopora meeki*, crinoid stems.

Station 6.—35 feet above the last station.

The following characteristic species of the Ithaca group occur here abundantly: *Atrypa reticularis*, *Spirifer mesacostalis*, *Strophodonta mucronata*, *Productella speciosa*.

Station 7.—242 feet above *Station 1*.

The following species occur here in the arenaceous, shelly sandstone: *Strophodonta mucronata*, *Spirifer mesacostalis*, *Atrypa reticularis*, *Microdon bellistriatus*.

Section VII, McKinney's Station.

This section extends from the base of the lower Portage into the Ithaca group. The exposures on which it is based occur along the east side of Cayuga lake from the point where the Genesee disappears beneath the lake to McKinney's station, and in the north glen at the station.

Station 1.—At the sinking of the Genesee beneath the lake.

About 10 feet above the lake, in the Portage shales, two species occur in some layers rather abundantly. These are *Glyp-*

tocardia speciosa and *Chonetes lepida*. A single small specimen of *Spirifer* resembling *S. mesastrialis* was found at this station.

Station 2.—About $\frac{1}{2}$ mile south of *Station 1*, at the side of the railroad, the following species were found: *Lunulicardium fragile*, *Glyptocardia speciosa*, *Goniatites sinuosus*, *Chonetes lepida*, *Coleolus aciculum*, *Strophodonta mucronata*, *Cladochonus* sp., *Lingula spatulata*, *Palæoneilo emarginata*.

The occurrence of *Strophodonta mucronata* here in the lower Portage fauna is of special interest since it is a very abundant fossil in the Ithaca group.

Station 3.—A short distance south of *Station 2*, at the side of the railroad, the following species have been obtained in the Portage shales: *Cladochonus* sp., *Strophodonta mucronata*, *Nuculites oblongus*, *Ambocœlia umbonata*, *Chonetes lepida*, *Pleurotomaria* sp., *Palæoneilo constricta*, *P. filosa*, *Glyptocardia speciosa*, *Coleolus aciculum*, *Lunulicardium fragile*, *Leptodesma sociale*?, *Goniatites discoideus*, *G. sinuosus*, *Loxonema* sp., crinoid stems.

Station 4.—In the north glen at McKinney's station, 20 feet above the lake.

In the tough arenaceous sandstone at this horizon, a second zone of *Spirifer lævis* has been discovered. The associated fauna of *S. lævis* at this horizon appears to be much less abundant than that of the upper zone. The only other species identified are *Strophodonta mucronata*, a species of *Macrodon*, and *Goniatites sinuosus*. The upper *S. lævis* bed in this section lies 110 feet higher.

Station 5.—35 feet above *Station 4* and 85 feet below the upper *Spirifer lævis* bed, the following species were obtained: *Glyptocardia speciosa*, *Rhynchonella pugnus*, *Coleolus aciculum*, *Aëlinopteria boydi*?, *Goniatites* sp., *Leda diversa*, *Grammysia* sp?, *Mytilarca chemungensis*, *Lunulicardium fragile*?

The discovery of *Rhynchonella pugnus* at this station extends its vertical range in this region from a limited zone in the Ithaca group into the middle Portage, about 100 feet below the base of the Ithaca group.

Station 6.—The shelly sandstone and silicious shale at this station which is 75 feet above the lake and 65 feet below the upper *Spirifer lævis* zone, contain an abundance of *Glyptocardia speciosa* and *Lunulicardium fragile*; associated with these are *Strophodonta mucronata*, *Palæoneilo filosa*, *Nucula diffidens*, *Goni-*

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Station 7.—The upper *Spirifer laevis* zone of the Portage is exposed here, 140 feet above the lake. *Spirifer laevis* occurs here even more abundantly than at the Fall Creek locality. The small number of associated species obtained is due doubtless to the small amount of time spent in collecting them. They are as follows: *Chonetes lepidus*, *Nucula* sp., *Crania* sp., *Leda diversa*, *Palæoneilo filosa* a, *Lunulicardium fragile*, crinoid stems.

The *S. laevis* bed is followed by about 20 feet of coarse shales alternating with thin bedded sandstone to the base of the Ithaca shale.

Station 8.—From the lower part of the Ithaca shale, 160 feet above the lake, the following species were obtained: *Lunulicardium fragile* a, *Leptodesma sociale* a, *Lingula complanata* a, *Coleolus aciculum*, *Conularia congregata*.

Station 9.—At the top of the falls, 225 feet above the lake, the dark blue shaly sandstone contains a sparse fauna from which the following species were recognized: *Productella truncata*, *Palæoneilo constricta*, *Pleurotomaria* sp., *Nucula* sp.

Station 10.—285 feet above the lake, the following species were collected: *Modiomorpha neglecta*?, *Palæoneilo constricta*, *P. filosa*, *Glyptocardia speciosa*, *Spirifer mesacostalis*, *Rhynchonella eximia*, *Nucula diffidens*, *Pleurotomaria* sp., *P. capillaria*, *Nuculites triqueter*, *Taxocrinus ithacensis*.

The finding of *Nuculites triqueter* at this station adds one more species to the list of recurrent Hamilton fossils in the Ithaca group.

The presence of *Glyptocardia speciosa* at this station is an interesting instance of the recurrence of one of the most characteristic lower Portage fossils in the Ithaca fauna above the Ithaca shale.

Station 11.—This station which is 300 feet above the lake and 160 feet above the upper *Spirifer laevis* zone is the highest point at which good outcrops can be obtained. The following species were found here: *Palæoneilo constricta*, *Leiorhynchus mesacostalis* a, *Chonetes scitula*, *Spirifer mesacostalis*, *Microdon gregarius*, *Rhynchonella eximia*, *Palæoneilo filosa*.

Section VIII, Glenwood.

The Glenwood section includes 385 feet of strata exposed by the stream entering the lake at Glenwood. The section begins in the Genesee shale and ends in the lower part of the Ithaca group. No collecting was done in the lower part of the section.

Station 1.—Just below the railroad, 170 feet above the lake.

The following characteristic lower Portage species were obtained here: *Glyptocardia speciosa* a, *Palæoneilo constricta*, *Goniatites sinuosus*, *Orthoceras* sp., *Ambocælia umbonata*.

Station 2.—210 feet above the lake.

The upper *Spirifer lævis* zone was found at this point. The fauna obtained here is as follows: *Spirifer lævis* a, *Orthoceras* sp., *Leda diversa*, *Plumulina plumaria*, *Palæoneilo brevis*, *Lunulicardium fragile*, *Aulopora* sp., *Lingula* sp., *Chonetes lepida*, *Grammysia subarcuata*, *Goniatites* sp., *Schizodus* sp?

Station 3.—260 feet above the lake.

The *Lingula* shale here contain abundant specimens of the following species: *Lingula complanata*, *L. punctata*, *Leiorhynchus mesacostalis*, *Productella speciosa*, *Psilophyton princeps*.

Station 4.—360 feet above the lake.

This station is above the Ithaca shale in the lower part of the Ithaca group. It is remarkable for the great abundance of the species which occur in the sandy shales, and for the presence of *Phacops rana* in abundance in a single layer. The list of fossils obtained is as follows: *Chonetes scitula* a, *C. setigera* a, *C. lepida* c, *Ambocælia umbonata* c, *Leiorhynchus mesacostalis* a, *Glossites depressus*, *Modiomorpha subalata* var. *chemungensis*, *Grammysia subarcuata*, *Lingula complanata*, *Palæoneilo constricta*, *Poteriocrinus* sp., *Rhynchonella eximia*, *Conularia congregata*, *Stictopora meeki*, *Crania hamiltonia* c, *Lepidodendron* sp., *Mesothyra* sp?

Station 5.—385 feet above the lake.

The species noted at this station are *Productella speciosa*, *Ambocælia umbonata*, *Orthoceras* sp., *Microdon gregarius*, *Modiomorpha subalata* var. *chemungensis*.

Section IX, Renwick Brook.

This section is located about $\frac{1}{2}$ mile north of the southeast corner of the lake. The vertical section studied here is about 250 feet in thickness, beginning below the upper *Spirifer lævis*.

bed of the Portage.

Station 1.—This station which is 45 feet above the lake, marks the position of the upper *Spirifer laevis* zone of the Portage. Very few fossils besides *S. laevis* were found; they consist principally of fragments of *Goniatites* sp., crinoid stems, *Orthoceras bebyx* var. *cayuga*, and *Glossites depressus*?

Station 2.—In the Ithaca shale, 50 feet above *Station 1*, the following fauna was found: *Lunulicardium fragile* a, *Leptodesma sociale* a, *Leiorhynchus mesacostalis*, *Goniatites discoideus*, *Lingula complanata*.

Station 3.—95 feet above *Station 1*, the following fauna occurs: *Leiorhynchus mesacostalis*, *Lingula complanata*, *Loxonema* sp., *Productella speciosa*, *Chonetes scitula*, *Orthoceras pector*, *Leptodesma sociale*.

Station 4.—155 feet above *Station 1*, the following species occur: *Pleurotomaria capillaria*, *Spirifer mesacostalis*, *Modiomorpha subalata* var. *chemungensis*, *Grammysia subarcuata*, *Palaeoneilo plana*, *Productella speciosa*, *Rhynchonella eximia*, *Leiorhynchus mesacostalis*.

Station 5.—*Plumulina plumaria* occurs at this point, 220 feet above *Station 1*, in a single stratum, in great abundance. Associated with it are *Rhynchonella eximia*, *Crania* sp., *Spirifer mesacostalis*, and *Ambocelia umbonata*.

Stations 6 & 7.—235 feet above *Station 1*, the following fauna occurs: *Rhynchonella stephani*, *R. eximia*, *Actinopteria* sp., *Gomphoceras tumidum*, *Euomphalus* sp?, *Ambocelia umbonata*, *Pleurotomaria* sp., *Chonetes setigera*.

Section X, Newfield Creek.

The exposures of the Newfield section occur along the gorge of Newfield creek. The section begins in the Ithaca group rocks and extends through them to the unfossiliferous flags and shales above. From the last station of this section, which is 350 feet above the Inlet valley, to the tops of the hills which rise 700 feet above the valley, the flags and shales appear to be entirely barren of fossils.

Station 1.—At the foot of the cascade at the lower end of the gorge, the rock is an arenaceous, shelly sandstone. The

horizon here is evidently above the Ithaca shale. Only a few fossils were obtained. *Palæoneilo constricta*, *Chonetes scitula* and *Nucula diffidens* being the most abundant.

Station 2.—Above the cascade, 60 feet higher than *Station 1*, the more common species are *Leiorhynchus mesacostalis*, *Modiomorpha subalata* var. *chemungensis*, *Ambocælia umbonata*, and *Nucula diffidens*.

Station 3.—At this station, 15 feet above the last, the predominant fossils are *Modiomorpha subalata* var. *chemungensis*, *Chonetes setigera* and *C. scitula*.

Station 4.—The predominant fossils at this point which is 160 feet above *Station 1*, are *Spirifer mesacostalis* and *S. mesastrialis*. Some of the associated fossils are *Cyrtina hamiltonensis*, *Rhynchonella eximia*, *Palæoneilo constricta*, and *Actinopteria perstrialis*.

Station 5.—180 feet above *Station 1*.

A calcareous layer about 18 inches thick occurs here containing an abundance of crinoid stems and Monticuliporoid corals.

The following species were obtained here: *Schizodus chemungensis*, *Glossites depressus*, *Stictopora meeki*, *Microdon gregarius*, *Actinopteria boydi*, *Callopora* sp.

Station 6.—195 feet above *Station 1*.

The abundant and characteristic fossils at this horizon are *Atrypa reticularis*, *Productella speciosa*, and *Spirifer mesacostalis*.

Station 7.—350 feet above *Station 1*.

This station is about $\frac{1}{2}$ mile below the village of Newfield at the first rock exposure below the flour mill. A remarkable recurrent Portage fauna occurs at this locality entirely above the Ithaca group fauna. The following species were obtained: *Glyptocardia speciosa*, *Lunulicardium fragile*, *Palæoneilo constricta*, *Coelolus* sp.

Prof. Williams has found, from about the same horizon, the following additional Portage species: *Lingula complanata*, *Bellerophon mæra*, *Sirophodonta mucronata*.

Above this station for a distance of more than 300 feet, the rocks consist of shales and thin bedded sandstones, and appear to be barren of fossils.

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TABLE SHOWING THE RANGE OF SOME OF THE SPECIES OF THE I

	Lower Portage.													Ith
	240	220	200	180	160	140	120	100	80	60	40	20	†	20
<i>Stiſtopora meeki</i>														
<i>Zaphrentis simplex</i>														
<i>Aulopora</i> sp.....													0	0
<i>Cladochonus</i> sp.....				0										
<i>Taxocrinus ithacensis</i>														
<i>Arthroacantha</i> sp.....														
<i>Strophodonta mucronata</i>					0		0	0		0				
<i>Strophodonta perplana</i> var. <i>nervosa</i>														
<i>Strophodonta demissa</i>														
<i>Productella hallana</i>														
<i>Productella speciosa</i>														
<i>Lingula spatulata</i>														0
<i>Lingula complanata</i>														0
<i>Lingula punctata</i>														0
<i>Cyrtina hamiltonensis</i>													0	
<i>Ambocælia umbonata</i>							0					0		
<i>Spirifer levis</i>							0						0	
<i>Spirifer mesastrialis</i>														
<i>Spirifer mesacostalis</i>														
<i>Orthis impressa</i>														
<i>Rhynchonella eximia</i>													0	
<i>Rhynchonella pugnus</i>									0					
<i>Leiorhynchus mesacostalis</i>													0	
<i>Cryptonella eudora</i>														
<i>Atrypa reticularis</i>														
<i>Chonetes scitula</i>													0	
<i>Chonetes lepida</i>	0				0		0						0	0
<i>Coleolus aciculum</i>							0		0					
<i>Tentaculites spiculus</i>														0
<i>Conularia congregata</i>														
<i>Pleurotomaria capillaria</i>													0	
<i>Bellerophon leda</i>														
<i>Bellerophon ithacensis</i>														
<i>Gomphoceras tumidum</i>													0	
<i>Goniatites sinuosus</i>					0		0	0			0			
<i>Goniatites discoideus</i>							0						0	
<i>Grammysia subarcuata</i>													0	
<i>Spathella typica</i>													0	
<i>Glyptocardia speciosa</i>	0				0	0			0	0	0		0	
<i>Schizodus chemungensis</i>														
<i>Leda diversa</i>								0					0	
<i>Lunulicardium fragile</i>					0		0		0	0			0	0
<i>Leptodesma sociale</i>							0?							0
<i>Mytilarca chemungensis</i>								0					0	
<i>Modiomorpha subalata</i> var. <i>chemungensis</i> ...													0	
<i>Microdon bellistriatus</i>														
<i>Microdon gregarius</i>														
<i>Nucula corbuliformis</i>														
<i>Nucula diffidens</i>										0			0	
<i>Palæoneilo constricta</i>											0			
<i>Palæoneilo filosa</i>						0				0			0	
<i>Aviculopecten cancellatus</i>														
<i>Pterinopecten erectus</i>														
<i>Pterinea (Vertumnia) reproba</i>														
<i>Phacops rana</i>														
<i>Plumulina plumaria</i>													0	

*The figures above each column in this table indicate the vertical distance above or below the upper *Spirifer levis* bed of the Po† *Spirifer levis* zone.

THE SPECIES OF THE PORTAGE AND ITHACA FAUNAS AT ITHACA, N. Y.*

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Spirifer laevis bed of the Portage. This table is based on four sections in which the *Spirifer laevis* zone has been ascertained.



PART III.**LIST OF SPECIES OCCURRING IN THE POTRAGE AND ITHACA GROUPS.**

The present list contains all of the species which have been found by the writer or reported by other from these faunas at Ithaca, together with notes on their range, abundance and variation.

Cœlenterata.*Cladochonus* sp.

An undetermined species of this genus is one of the most abundant and characteristic fossils of the lower Portage.

Aulopora sp.

A species of *Aulopora* attached to the valves of brachiopods is common at many localities in the Ithaca group and in the upper *Spirifer laevis* zone of the Portage.

Stromatopora sp.

This genus has been reported by Prof. Williams from the Ithaca group.

Stictopora meeki Nicholson.

A very abundant fossil throughout the Ithaca group.

Zaphrentis simplex? Hall.

Specimens resembling this species have been found at a single locality in a calcareous sandstone in Williams Creek section.

Callopora sp.

I have found an undetermined species of this genus occurring abundantly in a calcareous stratum at station 10-5.

Echinodermata.*Taxocrinus ithacensis* H. S. W.

A single perfect specimen from the Ithaca group at station 7-10 has been found.

Arthroacantha ithacensis H. S. W.

This crinoid is rather common at station 1-13 in the upper

part of the Ithaca group. The original specimens came from the bottom of the gorge below Triphammer falls.

Poteriocrinus cornellianus H. S. W.

Reported by H. S. Williams from the Ithaca group.

Poteriocrinus clarkei var. *alpha* H. S. W.

Lower Ithaca group.—H. S. Williams.

Poteriocrinus (*Decadocrinus*) *gregarius* H. S. W.

Ithaca group.—H. S. Williams.

Poteriocrinus (*Decadocrinus*) *zethus* H. S. W.

Portage group?—H. S. Williams.

Taxocrinus ithacensis var. *alpha* H. S. W.

Ithaca group.—H. S. Williams.

Taxocrinus curtus H. S. W.

Portage group.—H. S. Williams.

Molluscoidea and Mollusca.

Brachiopoda.

Discina neglecta Hall.

Upper Ithaca group.

Discina grandis? Hall.

Specimens which appear to belong to this species occur in the Ithaca group.

Lingula complanata H. S. W.

Abundant in the Ithaca shale.

Lingula punctata Hall.

Ithaca shale.

Lingula spatulata Hall.

Ithaca shale.

Lingula ligea Hall.

Ithaca shale.

Crania sp.

A species of *Crania* resembling *C. hamiltoniae* occurs through the Portage and Ithaca rocks.

Cyrtina hamiltonensis Hall.

Very abundant in the upper part of the Ithaca group.

The large number of specimens of this species which have been examined show but slight tendency to vary, except in size. Average specimens have a width of about $\frac{1}{2}$ inch along the hinge line; the longest noticed measured seven-tenths of an inch.

Ambocælia umbonata Conrad.

Abundant in the Ithaca group.

Strophodonta mucronata Hall.

Very abundant in the upper Ithaca group. It also occurs through most of the Portage.

Strophodonta perplana var. *nervosa* Hall.

Occurs in the Ithaca group but is less common than the preceding.

Strophodonta demissa? Con.

A rare species in the Ithaca group.

Produflus (*Produftella*) *hallanus* Walcott.

Two or three specimens of this species have been found in the upper part of the Ithaca group.

Produftella speciosa Hall.

This is an abundant and characteristic species of the Ithaca group. The larger specimens measure from four-fifths to one inch in width. The most abundant species associated with it in the Ithaca group are *Strophodonta mucronata*, *Spirifer mesacostalis*, and *Cyrtina hamiltonensis*.

Produftella truncata Hall.

This is a common species in the Ithaca shale. It seems to differ from *P. speciosa* only in size, some specimens measuring not more than one-tenth of an inch, while those of average size are from three-tenths to two-fifths of an inch in width. In the lower part of the Ithaca group, forms occur which seem to be intermediate between *P. truncata* and *P. speciosa*.

Spirifer mesacostalis Hall.

Abundant in the Ithaca group. *S. mesacostalis* shows a large amount of variation in specimens from the same horizon. Variation occurs principally in connection with four different characters,—the number of plications, the extent of the hinge line,

the character of the median fold, whether single or duplicate, and the presence or absence of a plication in the sinus. In fifty specimens examined, from 200 to 385 feet above the upper Portage *S. levis* zone, the number of plications varied from 12 to 24, the average number being 16. A very small per cent., perhaps one in 50 or 60, of specimens from the horizon of Triphammer falls and Eddy's dam (385 feet above the *S. levis* zone) show a duplicate median fold, and about the same number show a trace of a plication in the sinus. Neither of these characters have been noticed in specimens from below this horizon. All of the specimens which were properly preserved, show the distinct median septum extending nearly through the muscular scars in the ventral valve. The greatest amount of variation, however, is in the extent of the hinge line. In some specimens, the hinge line does not extend beyond the margin of the valves, while in others its delicate spine-like projections more than equal the width of the valves.

Spirifer levis Hall.

Prof. Williams has reported this species from the upper part of the Ithaca group and the writer has found several specimens of it 130 feet below the upper Portage *S. levis* zone, so that this species is now known to have a vertical range of not less than 500 feet.

Spirifer fimbriata Morton.

Lower part of the Ithaca group.—H. S. Williams.

Spirifer angusta Hall.

Lower Ithaca group.—H. S. Williams.

Spirifer mesastrialis Hall.

This is a very abundant species in the Ithaca group. It has not been found in the Portage.

Orthis impressa Hall.

This is one of the characteristic fossils of the Ithaca group. Most specimens have the length and breadth nearly equal, both dimensions averaging $1\frac{1}{4}$ inches. The Chemung form of this species differs from that at Ithaca, according to Prof. Williams, by having the shell wider than long.

Rhynchonella (*Stenoschisma*) *eximia* Hall.

Occurs through the greater part of the Ithaca group.

The forms described as *R. eximia* and *R. stephani* appear to be varieties of the same species. The larger specimens sometimes have a width of one inch, and the strong angular plications characteristic of *R. stephani*. The ratio of length and breadth varies considerably in different individuals; generally the length is slightly greater than the width, but in some individuals the length and breadth have the ratio of 8 to 11. The majority of the specimens are not more than $\frac{1}{4}$ to $\frac{1}{2}$ inch in width and have the finer plications of *R. eximia*.

Rhynchonella contracta Hall.

Lower part of the Ithaca group.

Rhynchonella pugnus Martin.

This species which has heretofore been known only in the Ithaca fauna, I have found in the Portage below the upper *Spirifer laevis* zone.

Leiorhynchus mesacostalis Hall.

This species is very abundant in the Ithaca group, occurring in some layers almost to the exclusion of other species. The specimens vary greatly in size, the largest measuring about $1\frac{1}{2}$ inches at the greatest width, while average specimens measure about $\frac{3}{4}$ of an inch. *Leiorhynchus sinuatus* is probably a small variety of this species.

Cryptonella eudora Hall.

This species appears to have a very limited vertical range. It occurs abundantly near the middle of the Ithaca group.

Atrypa reticularis Hall.

This species becomes abundant in the upper part of the Ithaca group. It seems to be entirely absent from the Portage and the lower part of the Ithaca fauna.

Atrypa aspera Hall.

Abundant at a few localities in the upper part of the Ithaca group.

Chonetes lepida Hall.

This is a common Portage species. It occurs in the Ithaca group, but less frequently.

Chonetes scitula Hall.

Specimens of the *C. scitula* type occur associated with *C. seti-*

gera, but are much less common than the latter. This species seems to be a variety of *C. setigera*; the same is probably, but less certainly, true of *C. lepida*.

Pteropoda.

Tantaculites spiculus Hall.

This is a rare species in the Ithaca group.

Styliolina fissurella Hall.

This species is recorded by Williams from the Portage and the lower part of the Ithaca group.

Coleolus aciculum Hall.

Common in the Portage and the Ithaca shale.

Hyolithes aelis Hall.

Lower Portage.—H. S. Williams.

Conularia congregata Hall.

Occurs in the Ithaca shale rarely; more common in the middle and upper part of the Ithaca group.

Coleoprion sp.

This genus is recorded by Williams from the upper *rifer* *levis* zone of the Portage.

Gastropoda.

Euomphalus (Straparollus) hecale Hall.

Ithaca group.—H. S. Williams.

Pleurotomaria capillaria Hall.

Common through the Portage and Ithaca groups.

Loxonema delphicola Hall.

This species is common in the lower part of the Ithaca group above the Ithaca shale.

Bellerophon leda Hall.

This is a rather rare species in the upper part of the Ithaca group.

Bellerophon explanatus? Hall.

A few specimens from the upper part of the Ithaca group, stations 2-9, 2-14, and 2-16, are referred with doubt to this

species. They are much smaller than the specimen figured by Hall, and have the dorsum flat instead of rounded as in that species.

Bellerophon ithacensis n. sp.,

Pl. 1, figs. 1, 2.

The specimens on which this species is based are somewhat distorted and crushed.

Shell of medium size. Width of flattened specimen greater than the length. The aperture is considerably expanded. Volutions apparently not more than one or two. The dorsum is marked with a sharp elevated carina.

The surface is marked by a peculiar wrinkling, varying in its development from roughly transverse striæ to a pustulose or reticulate surface.

The ornamentation of this species is unique, readily distinguishing it from any other of the genus.

From the Ithaca group, station 1-13.

Macrocheilus (Holoepa) macrostomus? Hall.

A single well-preserved specimen of this genus has been obtained from station 6-1, in the lower part of the Ithaca group.

Platystoma lineatum var. *callosum* Hall.

This gastropod is rather common in the University quarry associated with *Spirifer mesacostalis* and *S. messtrialis*.

Platyceras carinatum Hall.

Common at a few localities in the Ithaca group.

Cephalopoda.

Orthoceras fulgidum Hall.

This is rather rare in the Ithaca group.

Orthoceras leander Hall?

A few specimens from the Ithaca group are referred to this species.

Orthoceras pector Hall.

Two specimens were obtained from the Ithaca group at station 2-12.

Orthoceras anguis Hall.

Occurs in the upper *Spirifer laevis* zone of the Portage.

Orthoceras demus Hall.

Specimens referred to this genus were found in the Ithaca group at station 1-11.

Orthoceras leander Hall.

From the Ithaca group.

Orthoceras pertextum Hall.

This species is recorded from the Ithaca group by Hall.

Orthoceras bebryx var. *cayuga* Hall.

This is the most abundant species of *Orthoceras* found at Ithaca. It ranges throughout the Ithaca group.

Gomphoceras tumidum Hall.

This species is rather common in the Ithaca group. A small variety of it occurs in the upper *Sp. levis* zone of the Portage.

Porcellia nais Hall.*

This is a rare species occurring occasionally in the Ithaca group.

Goniatites sinuosus Hall.

This species ranges from the lower Portage through the Ithaca group.

Goniatites peracutus Hall.

A single well preserved specimen from station 4-2, about fifteen feet above the *Spirifer levis* zone. (Omitted in list, p. 23).

Goniatites complanatus Hall.

This is a common species in the Portage.

Goniatites discoideus Hall.

Common in the Portage.

Goniatites simulator Hall.

Ithaca group.—Hall.

Goniatites uniaangularis Con.

Some specimens from the Ithaca group are doubtfully referred to this species.

Pelecypoda.

Phthonia cylindrica Hall.

A single entire specimen of this species has been found at

*Classed by the writer among cephalopods, doubtless by mistake.—Ed.

station 6-1 in the Ithaca shale. It has not been reported before from the Ithaca group.

Pkithonia lirata Hall.

Ithaca shale.—H. S. Williams.

Pholadella radiata Hall.

Ithaca group.—Hall.

Spathella typica Hall.

Common in the Portage and Ithaca groups.

Schizodus chemungensis Hall.

This is a common species in the upper part of the Ithaca group at Ithaca.

Schizodus chemungensis var. *quadrangularis* Hall.

A few specimens have the distinctly erect form of the variety described as *quadrangularis* by Hall.

Glossites depressus Hall.

This species occurs in the *Spirifer laevis* zone, and is occasionally found in the Ithaca group.

Grammysia subarcuata Hall.

This is a common species throughout most of the Ithaca group. It also occurs in the upper Portage.

Prof. Hall has recorded the three following species of *Grammysia* from the "lower Chemung" at Ithaca: *Grammysia magna* Hall, *G. circularis* Hall, and *G. elliptica* Hall.

Goniophora minor Hall.

Rather common in the Ithaca group.

Goniophora hamiltonensis Hall.

This species occurs in the Ithaca group, but less commonly than the preceding.

Edmondia subovata Hall.

Common in the upper part of the Ithaca group.

Microdon (*Cypricardella*) *bellistatus* (Conrad) Hall.

Common throughout most of the Ithaca group. It has not been found in the Portage.

Microdon gregarius Hall.

This species is associated with the former, but is less common.

Microdon tenuistriatus Hall.

From the lower part of the Ithaca group.—H. S. Williams.

Conocardium liratum Hall.

This species is reported from the Ithaca group by Prof. Hall.

Glyptocardia speciosa Hall.

This species which is a characteristic and abundant Portage fossil, has been found in a recurrent Portage fauna above the Ithaca group; found occasionally in the midst of the Ithaca fauna.

Ptychodesma nanum Hall.

Ithaca group.—Hall.

Panenka sp.

Two imperfect specimens of this genus have been found in the Ithaca group in the Fall Creek section.

Macrodon chemungensis? Hall.

Specimens corresponding to the species except in surface marking, occur sparingly in the upper part of the Ithaca group. The surface of the shell is marked by indistinct concentric striae which are almost obliterated by reticulating lines which mark the surface of the shell with regular rows of small pustules, giving it a distinctly reticulated appearance.

Pararca sp.

A few fragmentary specimens of this genus have been found in the Ithaca group.

Nucula diffidens Hall.

This is a common species in the Portage and Ithaca groups.

Nucula corbuliformis Hall.

A few specimens occur associated with *N. diffidens* which appear to be identical with *N. corbuliformis* of the Hamilton.

Nucula lamellata Hall.

This is apparently a rare species in the Ithaca group. Two specimens.

Nuculites triqueter Con.

A single good specimen of this species was obtained from station 7-10 in the Ithaca group.

Palaeoneilo constricta (Conrad) Hall.

This is a very common fossil of the Portage and Ithaca groups.

occurring at nearly every station, and usually associated with *P. filosa*. It varies greatly in form and size.

The specimens referred to this species include many which correspond to Hall's figures of *P. maxima*, but which seem to be only variations of the *P. constricta* type.

Palæoneilo constricta var. *flexuosa* (Conrad) Hall.

Ithaca group.—Hall.

Palæoneilo filosa Con.

This is a common species of the Portage and Ithaca groups. It shows comparatively little tendency to variation. Well preserved specimens show distinct, fine striæ between the coarser ones on the posterior part of the shell, similar to *P. secunda*.

Palæoneilo plana Hall.

This species occurs in the Ithaca group, but is much less common than the two preceding.

Palæoneilo emarginata? (Conrad) Hall.

Two imperfect specimens from the Ithaca group are referred to this species.

Leda diversa Hall.

This species is rather common in the Portage and Ithaca groups.

Leda curta? Meek.

Lower Portage.—H. S. Williams.

Leda perstriata Hall.

Upper *Spirifer laevis* zone.—H. S. Williams.

Modiomorpha subalata var. *chemungensis* Hall.

This is one of the most abundant species in the Ithaca group.

Modiomorpha subalata Hall.

Some specimens from the Portage and Ithaca groups correspond to *M. subalata* of the Hamilton.

Modiomorpha concentrica Hall.

A few specimens have been found in the Ithaca group.

Modiomorpha complanata Hall.

From the lower part of the Ithaca group.—H. S. Williams.

Modiomorpha neglecta? Hall.

A single specimen from station 7-10 is referred to this species.

Mytilarca chemungensis Hall.

This species is common at station 4-5, and from a few localities in the Ithaca group.

A single specimen from the *Spirifer laevis* bed at Ithaca falls differs from the ordinary specimens of *M. chemungensis* in its erect form and small size.

Mytilarca umbonata Hall.

From the Ithaca group.—Hall.

Leptodesma sociale Hall.

This is a characteristic species of the Portage and Ithaca shale, and occurs less frequently in the Ithaca group. Different individuals show great variation in the extension of the wing, the gibbosity of the shell, and the obliquity of the body. Some specimens correspond closely to Hall's figures of *L. potens* and *L. potens* var. *juvens*, but they probably represent variations of *L. sociale*.

Leptodesma sp?

Imperfect specimens of one or two large species of *Leptodesma* have been found in the upper part of the Ithaca group.

Leptodesma naviforme Hall.

From the Ithaca group.—Hall.

Pterinea (Vertumnia) reproba Hall.

Common in the upper part of the Ithaca group.

Pterinopecten erectus Hall.

This is a rare species. A few specimens have been obtained from the Ithaca group at the University quarry and in Fall creek.

Pterinopecten suborbicularis Hall.

Occurs in the Ithaca group.—H. S. Williams.

Aviculopecten cancellatus Hall.

From the Ithaca group.—H. S. Williams.

Aviculopecten fasciculatus Hall.

This species is rather rare in the Ithaca group. One specimen referred to this species is from station 2-14.

Aviculopecten striatus? Hall.

Specimens which appear to belong to this species are found

occasionally in the Ithaca group.

Aviculopecten rugæstriatus? Hall.

A few specimens which are found in the Portage and Ithaca groups are doubtfully referred to this species.

Aviculopecten lautus var. *ithacensis* n. var.,

Pl. I, fig. 3.

The specimen on which this variety is based differs from *A. lautus*, figured by Hall, in having the beak prominent, the hinge line much shorter than the width of the shell, very distinct concentric striae, and only a portion of the strong rays with intermediate finer ones.

The left valve has a width of nine-twentieths and a height of two-fifths of an inch.

From the Portage at the foot of Ithaca falls.

Aëlinopteria sp.

Specimens of this genus are common through the Ithaca group and upper Portage. Prof. Hall has described ten species of *Aëlinopteria* from Ithaca. These probably represent variations of two or three species. All I have seen I have been able to refer to the three following species:—

Aëlinopteria tenuistriata Hall.

A few specimens from the Portage and the lower part of the Ithaca group are referred to this species.

Aëlinopteria boydi Hall.

Typical specimens of this species are abundant at Triphammer and other localities in the upper Ithaca fauna.

Aëlinopteria perstrialis Hall.

Specimens referred to this species are common in the Portage and Ithaca rocks.

The points of difference made by Hall between his Ithaca species of *Aëlinopteria*, are shown in the following synopsis of their characters:—

Analytical key to the species of Aëlinopteria.

- A. Body nearly erect, broadly ovate; hinge line extended.
 - A. Concentric striae crenulating the rays and bending back in the interspaces. *Aëlinopteria zeta*.
 - A'. Concentric striae not crenulating the rays nor bending back in the interspaces; form quadrate. *A. tenuistriata*.

B. Body not very oblique.

B. Surface marked by concentric striae which curve backward between the radii.

$\beta 1$. Strong radii, usually without interstitial additions. *A. boydi*.

$\beta 2$. Slender radii with interstitial additions.

$b 1$. Body broadly ovate; oblique, at an angle of about 55° . *A. theta*.

$b 2$. Body broad and short ovate; oblique, at an angle of about 45° . *A. eta*.

B'. Surface not marked by concentric striae which curve backward between the radii.

$\beta' 1$. Strong elevated rays and wider interspaces. *A. epsilon*.

$\beta' 2$. Radii, fine.

$b' 1$. Body at an angle of about 60° with the hinge. *A. delta*.

$b' 2$. Body at an angle of about 45° with the hinge.

$b' 1$. Shell small, body subrhomboidal, subovate. *A. perstrialis*.

$b' 2$. Shell of medium size, rhomboidal, body broadly ovate. *A. iota*.

C. Body very oblique.

Radii filiform, interrupted and undulating. *A. kappa*.

Crustacea.

Phacops rana Hall.

This species is abundant at a single locality in the Ithaca group, station 8-4.

Mesothyra oceani Hall.

This is a rare species in the Portage group.

Vertebrata.

Pisces.

Dipterus ithacensis H. S. W.

Lower Ithaca group and Ithaca shale.—H. S. Williams.

Plantæ.

Plumulina plumaria Hall.

This species occurs abundantly at many localities in the Ithaca group. I have also found it in the upper *Spirifer lævis* fauna at Glenwood.

Psilophyton princeps Dawson.

Common in the Ithaca shale and Portage group.

Rachiopteris punctata Dawson.

Occurs in the Ithaca shale.—H. S. Williams.

Lepidodendron sp.

Fragments of a species of *Lepidodendron* have been found in the Ithaca group at station 8-4.

TYPICAL CHEMUNG FAUNA.

The Chemung fauna does not occur in any of the Ithaca sections, but the following list represents it at the typical locality, near Chemung village, as determined by Prof. Williams*:

Orthis tioga, *Streptorhynchus chemungensis*, *Aviculopecten pecteniformis* Hall, *Pterinea chemungensis* (Con.) H. S. W., *Strophodonta cayuta*, *S. demissa*, *Productella lachrymosa* var. *lima*, *P. costatula*, *Spirifer disjunctus*, *Ambocælia umbonata* var. *gregaria*, *Atrypa reticularis*, *Rhynchonella contracta*, *Leiorhynchus sinuatus*, *L. mesacostalis*, *Cryptonella eudora*, *Pteronites spinigerus* Con., *Pterinea protexta* Con., *Avicula multilineata* Con., *Cypricardites* (*Goniophora*) *chemungensis*, *Schizodus* (*Nuculites*) *chemungensis* (Con.), *Grammysia subarcuata* H. & Whit.

The rare species are *Chonetes setigera*, *C. illinoisensis*?, *Pleurotomaria capillaria*, *Euomphalus* sp., *Collonema* sp., *Rhynchonella* *cappho*, *Orthis michelini* L'Ev. (if distinct from *O. vanuxemi*), *Glyptodesma* sp., *Bellerophon mæra*, *Platyceras* sp., *Cyclonema* sp., *Orthis carinata*, *O. leonensis*, *Knorria* sp., *Cladochonus* sp., *Strophodonta perplana* var. *nervosa*, *Taxocrinus ithacensis*, *Gomphoceras* sp., *Spirifer fimbriata*, "*Fucoides graphica*," *Spirifer mesacostalis* (2d var.), *Atrypa aspera*, *Orthis impressa* (wide var.), *Rhynchonella orbicularis*, *Discina grandis*, *Mytilarca chemungensis*.

* Bull. U. S. Geol. Surv., No. 3.

PART IV.

SUMMARY.

The detailed lists of the preceding pages show that we have represented here four faunas. The work of Dr. H. S. Williams* has left little to be done in determining their composition and order of sequence. The efforts of the writer have therefore been directed toward ascertaining the extreme limits of the vertical range of the several species beyond their zone of culmination, by a minute study of several sections. A precise knowledge of the vertical range of the dominant species of a fauna is very essential to a correct interpretation of its history. If the principal species of a fauna can be shown to be entirely absent from the beds below it, then it may be considered a migratory fauna. The scarcity of the principal representatives of a fauna below their horizon of culmination might give a locally developed fauna the appearance of having migrated into a region.

The principal result of this study has been to extend the vertical range of some of the well known species of these faunas, and to determine more definitely that of others. The range of a number of these is shown by the table. By reference to the same, it will be seen that two of the most abundant and characteristic Portage species, *Glyptocardia speciosa* and *Lunulicardium fragile*, have been found in the midst of the Ithaca group. One of the most interesting of such forms here—*Spirifer laevis*—has been found 110 feet below the well known zone at the base of Ithaca falls. Some of the species of the Ithaca fauna not previously known below it, have been found in the Portage rocks. One of the most interesting of these is *Rhynchonella pugnus* Martin, which I have found at station 7-5. *Plumalina plumaria* has been found at a few localities associated with *Spirifer laevis* near the middle of the Portage.

The number of recurrent Hamilton fossils previously known from the Ithaca group has been increased by the discovery of some additional species. These are *Phacops rana*, which occurs abundantly in a single layer in the Ithaca group (station 8-4), *Orthis vanuxemi*, also abundant at a single locality (station 6-1), *Modiomorpha mytiloides*, *Nuculites triqueter*, *Strophodonta perplana*, *Phthonia cylindrica*.

* Bull. U. S. Geol. Surv., No. 3.

A comparison of the Ithaca and Portage faunas shows that nearly all of the typical Portage species occur, though less abundantly, in the Ithaca fauna. Some of the most abundant species of the Ithaca fauna, *Cyrtina hamiltonensis* and *Strophodonta mucronata*, are present in the Portage. A few of the most distinctive species of the Ithaca fauna as *Cryptonella eudora* and *Spirifer mesacostalis*, are not found in the Portage and the Ithaca shale. The prevalence of the Ithaca shale conditions and the *Lingula* fauna probably led to the shifting of some of the Portage species, since they appear to be absent from the Ithaca shale; with the return of sandy sediments, the Portage species, some of which were thinned almost to extinction, were accompanied by Hamilton species which were probably derived from the east and by others not before known from the New York system, giving rise to the cosmopolitan Ithaca fauna.

An examination of the Chemung fauna also reveals its close relationship to the Ithaca fauna. Several of the species are common to both. There is, however, a smaller per cent. of species common to the Chemung and Ithaca, than of those common to the latter and the Portage fauna. This together with the fact that Portage species occur in the Ithaca group, and that a typical Portage fauna occurs above the Ithaca, seem to indicate that the latter has a closer relationship to the Portage and should be classed in the Portage epoch.

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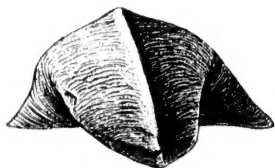
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Plate 1.

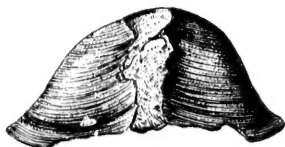
EXPLANATION OF PLATE I.

(I)

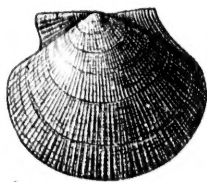
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Fig. 1. <i>Bellerophon ithacensis</i> n. sp., x2.....	39, 39.
Dorsal view.	
2. <i>Bellerophon ithacensis</i> n. sp., x2.....	39, 39.
Showing part of peristome.	
3. <i>Aviculopecten lautus</i> var. <i>ithacensis</i> n. var., x2..	45, 45.
Left valve.	



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